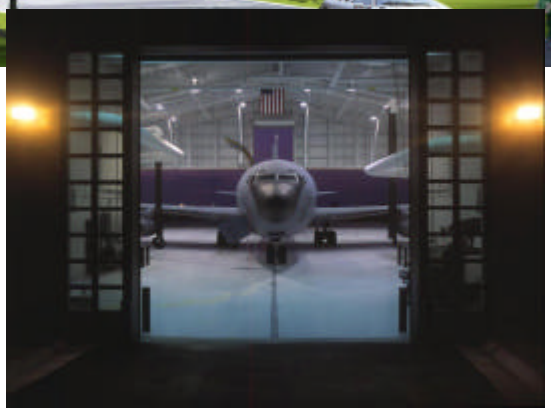
AIR NATIONAL GUARD DESIGN POLICY
ANG ETL 01-1
FINAL







AIR NATIONAL GUARD

DESIGN POLICY

INDEX

(Revised September 2001)

SECTION 1 DESIGN CODES AND REFERENCES

1.1. DESIGN CODES: Major design codes and standards, which are applicable to all Air National Guard (ANG) construction, are indicated below. This listing is not intended to be all-inclusive. It is the Base Civil Engineer's (BCE's) responsibility to furnish the Architect-Engineer (A-E) those codes having an Air Force (AF) or Air National Guard (ANG) designation. It is the A-E's responsibility to have or procure all other applicable codes and standards.

DESIGNATION	TOPIC
Uniform Building Code, BOCA, Southern Building Code, International Building Code	Model Building Codes. Use the nationally recognized building code with state amendments accepted locally when the ANG is not a tenant on an Air Force Base.
Air Force Regulations	Apply as directed and when the ANG is a tenant on an Air Force or Reserve Host Base.
Mil. Handbook 1022 AF Std 78-24-27 AF Std 78-24-28-88	Petroleum Fuel Facilities
National Fire Code	Fire Protection
ASHRAE	HVAC Design
NRCA 5th Edition	Roofing and Waterproofing Manual
ASHRAE Std 62-89 (R) ASHRAE Std 90.1 AFOSH Std 161-2	Ventilation
ASCE 7-98 or latest edition	Vertical and Horizontal Design Loads
ACI 302.1	Concrete Floor Slabs on Grade
Standards established by the public utility having jurisdiction	Water, Sewer, Storm Drainage, Electrical furnished by public utilities
Code of Federal Regulations, State Regulations where State has jurisdiction	Energy, Environmental Protection, Safety
OSHA AFOSH	Safety
NEC	Electrical Design

1.2. DESIGN REFERENCES: References are made throughout this Air National Guard Design Policy to Air National Guard Engineering Technical Letters (ANG ETL's), Technical Orders (T.O.'s) and other criteria. These references are identified to provide guidance in implementing uniform design policy for all ANG facility construction. It is the BCE's responsibility to furnish the A-E those references, which are applicable to a particular project. Most Air Force publications may be obtained at http://afpubs.hq.af.mil/. Many ANG publications may be obtained from https://airguard.ang.af.mil/ce/.

1.3. APPLICABILITY OF CODES AND REFERENCES: All requirements of codes and design references are to be carefully integrated into the applicable design unless specifically addressed by ANG ETL or waived in writing by ANG/CE.

SECTION 2 GENERAL DESIGN INFORMATION

2.1. POLICY: Air National Guard facilities shall be similar in quality to those facilities found in the private and corporate sector of their local communities. Air National Guard projects shall provide clean, architecturally compatible, yet non-monumental solutions to facility requirements. Facility designs shall avoid the appearance of waste or excessive cost. Architectural style and detail shall be based on sound facility architectural principles and shall be developed to maximize facility flexibility. Building and site design shall present a unified campus setting, reflecting the existing or developing master architectural standards of the base. Facility and site design shall also comply with the approved base master plan. Designs between facilities (administrative, industrial, aircraft) that differ in use shall be coordinated so that a unified architectural theme is provided between the various base facilities. All aspects of facility construction shall be carefully considered for their architectural impact. Construction materials shall be specifically selected by the designer for durability, aesthetics and low maintenance/maintainability features. Building and site designs shall thoughtfully provide for the large monthly drill weekend unit training assembly (UTA) occupancy, while economically accommodating the much smaller daily population.

Headquarters Operations and Training - Above Dining Hall/Multi-Purpose Facility

2.1.1. Project site design (roads, storm water control, utility infrastructure, etc.) shall provide for immediate facility needs but shall also consider and support long range base site and facility requirements.

2.1.2. Site landscaping shall be provided and shall enhance the overall image of the facility and the base using economical and low maintenance methods and materials. See Section 7 of this Tab, LANDSCAPING, for additional information.

2.1.3. Project designs shall be comprehensive, providing concise specifications for all materials and work actions and drawings complete with abundant detail, sections, notes and schedules.

Squadron Operations and Fighter Training Unit Complex

2.2. GENERAL:

2.2.1. Design and construction of all ANG facilities and infrastructure shall comply with nationally recognized, locally adopted building code criteria, except where specific Government criteria are more restrictive. ANG ETL's and other ANG/AF construction criteria shall supercede other criteria when conflict arises. See ANG ETL 90-9, "Compliance with Building Codes." Where indicated and where applicable, specific Air Force ETL requirements shall be incorporated into ANG design and construction.

2.2.2. The A-E shall not pay for local, state or federal construction permits. The A-E shall not pay for any local reviews.

2.3. EQUIPMENT AND FURNITURE:

2.3.1. Equipment and freestanding furniture items which are neither affixed nor built into the designed construction cannot be purchased using construction funds. Equipment funds (another funding source) shall be used instead. The BCE shall provide specific direction to the A-E regarding equipment and furniture requirements.

2.4. DRAWINGS:

2.4.1. Include appropriate Base standard cover sheet on all drawing sets. Clearly indicate on the cover sheet the approved ANG project title, project number and level of design development at each submission.

2.4.2. Civil site plan drawings shall include all soil boring logs and locations. It is recommended that a specific civil site plan sheet clearly differentiate all of the various site finishes and materials and also clearly show all pavement jointing plans and patterns. Include full details or reference thereto, of all jointing, joint sealing and other related civil horizontal work. Topographic information shall generally be at not more than one-foot increments. Civil site plans shall also clearly demonstrate coordination with all adjacent existing or new construction. Generally, show as-built information on adjacent sites to a minimum 6.1 meter (20 foot) distance.

2.4.3. Structural sheets shall indicate all roof and floor design loads, slab jointing requirements, soil bearing values and structural material strengths.

2.4.4. Architectural drawings shall provide detailed architectural elevations of all views (Including hidden views if any). Architectural elevations shall show all exterior items such as mechanical and electrical equipment and materials, communications equipment, dumpsters, cargo or storage items, courtyards and screening walls and reflect their impact on overall architecture. The architectural elevations shall clearly show finish grade line. For presentation purposes (at concept and pre-final stages), provide color versions in proposed finish palettes.

2.4.4.1. Architectural drawings shall also provide a table or schedule showing total specified U-values for walls, roofs, ceilings, floors, doors and windows on all typical exterior sections.

2.4.4.2. Finish schedules shall be developed and shown in table format in the architectural drawings for finish and color of all facility exterior construction. This shall include all wall and roof mounted items. It shall also include all mechanical, electrical and communications items, all site equipment, piping, conduit, boxes, etc.

2.4.4.3. Finish schedules shall be developed in table format in the architectural drawings for finish and color of all facility interior surfaces and materials.

2.4.4.4. Acoustic sound transmission schedules for various rooms and wall types shall be shown on the architectural drawings. Maximum noise criteria for each space shall be indicated and a requirement for contractor acoustic testing of each space to verify conformance with sound transmission and noise criteria shall be included in the specifications.

2.4.5. Roofing drawings shall include complete plan sets and elevations. Include abundant details reflecting full compliance with NRCA construction and details or similar criteria for roofing type. Symmetrically locate all penetrations on the roof and include detail for each penetration. All roofing systems require gutter and controlled drainage and these requirements shall be fully detailed. Reference Section 6 of this Tab, ROOFING, for additional guidance.

2.4.6. Mechanical drawings shall include but not be limited to:

- Mechanical system layout and details
-Chilled water and Hot water system layout and details
-Gas system layout and details (as applicable)
-Duct systems layout and details
- System flow diagrams
- Mechanical room floor plans
- Mechanical system and equipment facility installation elevations and sections
- Appropriate mechanical room elevations, sections and details
- Mechanical equipment schedules
- HVAC system control diagrams
- Sequence of operations information and temperature set points
- Plumbing system layout and isometric riser diagram
- Plumbing system elevations, sections and details
- Plumbing fixture schedule

Show locations of all mechanical equipment and other items to scale. Coordinate with and locate all electrical items that service the mechanical devices such as DDC control panels, variable speed control panels, motor control centers, disconnects, etc. All mechanical equipment shall be shown on mechanical schedules. Include all characteristics and specified efficiencies of equipment on the schedules. Include a schedule for all diffusers, registers and grills, indicating style, CFM, throw, drop and noise criteria. Include abundant detail, sections and elevations for all equipment, systems and sub-system components. Demonstrate on mechanical design sheets full capability for maintenance and repair of equipment such as shaded area demonstrating clear area for tube or bundle pull, or showing clearly access points, accessibility and avenues for maintenance and repair of all items. Reference Section 10 of this Tab, MECHANICAL – HVAC AND PLUMBING, for additional guidance.

2.4.6.1. For projects involving POL design and construction, show all systems, layouts and details in accordance with the given ANG and AF design policy as well as Military Handbook 1022.

2.4.7. Fire protection drawing requirements are more fully outlined in Section 15 of this Tab, FIRE PROTECTION. In general, all project designs shall have separate fire protection drawing sheets. The fire protection drawings shall include a life safety analysis sheet, hazard and occupancy classification floor plan and diagrams. Show all fire rated walls with fire rating indicated on a floor plan sheet. Locate all fire dampers/fire rated penetrations on this sheet as well. Also include the fire suppression riser diagram (where required) and detail other system design requirements such as hazard classification, sprinkler density, water source, available flow data and other relevant information.

2.4.8. Electrical drawings shall include complete power riser diagram (one-line diagram), emergency power diagram, security riser diagram and riser diagram for each communication system (telephone, CCTV, computer, public address, fiber optic, etc.). Provide separate fire alarm riser diagram. Show locations of all fire detection system components on a dedicated fire protection sheet and do not combine with lighting plans, communications layout or other electrical systems designs. Also provide separate riser diagrams for IDS systems, grounding systems as required, lightning protection systems, lighting fixture schedule, and panel board schedules. Clearly identify the classification and limits of each hazardous zone on the drawings using both floor plan and cross section details.

2.4.9. Drawings shall be produced in AutoCad® or other base standard software. Drawing standards and format shall be as indicated by the base. Provide the above-indicated information on the drawings, even if contained elsewhere in the project documentation. Provide drafting using most recent edition of software. Provide for design finals as well on CD disc as well as plotted Mylar drawings. As-built records completed on CD and plotted on Mylar sheets shall be completed by the A-E and shall be negotiated as part of the contract C services. If C services are not anticipated, include the as-built requirement as a contractor deliverable.

2.5. SPECIFICATIONS:

2.5.1. Do not use terms such as architect, engineer or owner; instead, use the term contracting officer.

2.5.2. If listing brand names, list at least three brands complete with model numbers and/or any accessory part numbers, if required for complete usable unit, followed with an "or equal" clause. Include a full specification description of all salient characteristics of all materials and equipment even if offering suggested brand names. See NGB-AQ Letter 92-6, "Architect and Engineer and Construction Contract Formats," and FAR 52.236-5, "Material and Workmanship."

2.5.3. For projects estimated to cost over $1 million, include specification requirements for a contractor-prepared and contractor-maintained critical path method (CPM) construction schedule using the arrow diagramming method. Specifications shall state that the CPM schedule can be used in lieu of AF Form 3064, Contract Progress Schedule, providing a process is instituted to validate the contractors percentage of completion for verifying payment vouchers. Reference applicable ANG ETL for additional guidance.

2.5.4. Prepare and edit specifications, cost estimates and other documents in the most recent release of Microsoft Word® and Microsoft Excel®.

2.6. CONVERSION TO METRIC: All ANG construction documentation drawings and specifications shall fully comply with the soft metric conversion practices as required by ANG ETL 94-2.

2.6.1. In the event of conflict between the Metric units indicated in this ETL and the given English units, the given English unit shall be used.

2.7. REQUIREMENTS:

2.7.1. The annotation NSR (no special requirement) as found in Tab A of the project book, is only an indication that there are no user known special or unique ANG mission requirements for that space (other than those identified in other portions of the project book). Requirements that are ordinarily included in that type of space, that are required by other portions of the project book or that are code/ETL requirements shall be provided, whether indicated in the Tab A, or not. In some instances, requirements that are included in other portions of the project book or that are ordinarily required by function or code are listed redundantly in the special requirement section (Tab A).

2.7.2. The BCE and each individual using activity (through the BCE) shall provide to the A-E (upon A-E request) all the information necessary to properly design a space for the required use and for the equipment to be installed. The A-E shall be responsible for providing a design that properly accommodates the intended use of each specific space.

2.7.3. The A-E shall be responsible for incorporation of the project book (All Tabs) requirements into the design documents and for demonstration that incorporation has been accomplished.

2.8. COORDINATION AND STANDARDIZATION:

2.8.1. Site Coordination between multiple projects and specifically between adjacent sites is of critical importance. Designs for facilities must reflect that coordination between it and the adjacent facilities/utilities and for the overall site development has been accomplished. Show most current work of adjacent project designs or existing area(s) on each specific project site plan so that this requirement can be achieved. Demonstration that coordination as to the overall base color palette, architectural theme, parking, roadway and sidewalk requirements, site grading and storm flow, hardware, lighting, utility, signage and other elements must be accomplished.

2.8.2. Coordination for interior and exterior finishes and color selections between multiple projects and specifically between adjacent (new or existing) facilities is of utmost importance. Designs for each facility must reflect that coordination between it and the adjacent area has been accomplished. All features shall reflect architectural coordination and shall show finishes reflecting approved and coordinated requirements. Proposed color and finishes boards shall be presented with demonstration of required coordination.

2.8.3. Standardization. Facility designs shall reflect careful consideration and coordination of standardized features. All designs shall incorporate standardization to the maximum extent possible. Certain features such as base-wide lock and keying systems, DDC and EMCS systems, fire detection/reporting systems, security and IDS systems, communications systems and other similar systems that are located in multiple facilities shall be of the same manufacturer (standardized) to the maximum extent capable. This will ensure compatibility, maintainability and operations. Other base features such as exterior lighting, signage, curb styles, color palate, etc., shall be standardized as to style, shape colors and even manufacturer, to the fullest extent possible, for a unified and cohesive base appearance.

2.9. MANUALS, INSTRUCTIONS AND TRAINING:

2.9.1. Complete Operation and Maintenance manuals shall be specified and shall be provided for each facility or for each project. Specifications shall be concise and comprehensive regarding requirements for project O&M manuals. Manuals shall include original data on all materials, systems, components and equipment provided for facility construction. This shall include information on all systems such as Mechanical, Plumbing, Electrical, Fire Protection, Security, Communications and Roofing, etc. Additionally, information on all building materials (windows, doors, hardware, brick, block etc.), equipment (generators, air compressors, vaults, etc.) and all building finishes (tile, vinyl wall finishes, ceiling tile, paints, wood materials, stains and finishes, colors used, etc.) shall be included. Manuals must be professionally prepared including printed spine and cover with full table of contents and tabbed indexing. Full size sheets and diagrams shall be folded into special pocket holders.

2.9.2. Manuals shall have a separate tabbed index that contains all warranty information as required by contract. Require submission of a minimum of two copies of the manuals, one for the BCE library and one to be placed in the facility mechanical room wire cage lock box. Specifications shall require that the manuals be submitted for Government review at no later than 80% construction completion.

2.9.3. Comprehensive posted operations instructions (POI's) shall be specified for all facility construction. Specifications shall fully outline provision requirements of the POI's and outline requirements for operating diagrams/wiring diagrams for all equipment and systems in each facility. Instructions shall be developed as CADD schematics, files or plans and include printed text and shall be framed under glass with extruded metal frame and shall be bolted to the wall. Instructions shall be in color and use color graphics for illustrative purposes. Instructions shall be bolted to mechanical room walls in the space reserved for them. As an alternative to posting in mechanical rooms, POI's may be incorporated into the graphics package of the base central EMCS system.

2.9.4. Provision for equipment commissioning and ANG personnel training shall be comprehensively specified. Training of ANG personnel in maintenance and operations of all equipment and systems installed must be specified. This shall include onsite, hands on training, classroom training and as required off site factory classroom training.

2.9.5. Reference Section 10 of this Tab, MECHANICAL – HVAC AND PLUMBING, for additional guidance on the above items.

2.10. SEISMIC: All facilities and construction shall conform to the minimum seismic design criteria for the local seismic zone.

2.11. SUSTAINABLE DESIGN: Project specifications shall require that designated items of construction be composed of the highest practical percentage of recovered materials. The designated items are listed in the EPA Comprehensive Procurement Guidelines for recycled-content building materials. Project requirements shall conform to public law 40 CFR 247.

SECTION 3 ECONOMIC ANALYSIS

3.1. INTRODUCTION: Economic analysis plays an important role in the development of a design, providing cost comparison and justification between reasonable design choices. These choices are in the types of mechanical systems, roof systems, wall systems, structural systems and such that form the early decisions of the major building features, components and systems which have the greatest construction cost impact. Economic analysis must carefully consider the durability, maintainability and longevity of the considered systems and factor these elements into the equation. Justification and selection of systems must not be made on first cost alone. The procedure for doing an economic analysis is described in the following paragraphs.

3.2. ARCHITECTURAL AND STRUCTURAL:

3.2.1. Alterations and Additions (Existing structures).

3.2.1.1. Simply state what materials are compatible for matching an existing facility architectural treatment and show the cost of each in the same unit basis for comparison.

3.2.1.2. Structural systems need not match existing, and need only be limited by durability, cost and feasibility. Simply state what structural systems are most suited for facility durability, feasible to construct and state the cost of each in the same unit basis for comparison.

3.2.2. Single and Multiple Building Facilities (New facilities).

3.2.2.1. State for general comparison all feasible types of architectural and structural systems that would comply with paragraph, "INTRODUCTION," above. Show a general cost for each in the same unit basis. Architectural systems include wall and roof systems. Structural systems include foundation system and structural framing system for floors and roof.

3.2.2.2. Select a minimum of three of the more promising economical systems for a more detailed analysis. Show a simple sketch on a page detailing material composition and layout of each system.

3.2.2.3. Provide a brief narrative of the selection of each system, which considers the function of the facility, durability and maintainability features of each system, architectural appearance and other important considerations.

3.2.2.4. Show the cost of each system based upon its initial construction cost and the general maintenance cost expected over a 25-year period. Where a system provides a related benefit of reducing utility (energy) costs, this shall also be considered.

3.2.2.5. Summarize the analysis by providing a brief narrative of the final selection of each system which fully considers the function of the facility, durability, maintainability, architectural appearance and reflects sound value engineering judgment.

3.3. MECHANICAL:

3.3.1. All HVAC system selections will be based on a comparative cost analysis of a minimum of three system schemes. Items to be included in the analysis are: first cost, operating cost and maintenance cost based on a 25-year facility life as well as system performance expectations, reliability and maintainability. Reliability and maintainability of the HVAC systems is of primary importance, so considered systems must first satisfy those criteria. All mechanical systems considered shall also take into account the need to efficiently accommodate both the UTA weekend facility use and the much lower daily weekday occupancy. Based on these analyses the A-E shall recommend the optimum system.

3.3.2. Heating fuels, heating/cooling plants, and types of heating/cooling systems are to be selected on the basis of overall economy by considering compliance with air/water pollution regulations, fuel availability and cost, installation costs, annual energy consumption and costs, reliability, maintainability and annual operation and maintenance (O&M) costs.

3.3.3. Special Considerations:

3.3.3.1. Multiple Facilities. Where more than one facility is to be constructed, additional cost data shall be provided comparing a central heating and/or cooling plant to individual heating and cooling systems for each facility.

3.3.3.2. Central Heating and/or Cooling Systems. Where an existing central heating and/or cooling system is available to service one or more facilities, additional cost data shall be provided comparing the central heating and/or cooling system to an individual heating and/or cooling system for each facility.

3.3.3.3. Additions/Alterations to Existing Facilities. Where an addition or alteration is to be accomplished to an existing facility having an existing heating and/or cooling system, the following cost data shall be provided:

a. Estimated cost to extend the existing heating/cooling systems to the addition/alteration.

b. Estimated cost to install a separate heating/cooling system for the addition/alteration only.

c. Estimated cost to install a new heating/cooling system for the entire facility.

In addition, an analysis of the existing system and its ability to properly serve the addition or alteration shall be provided. Existing system age, efficiency, reliability and serviceability shall be taken into consideration.

3.4. ELECTRICAL:

3.4.1. Determine and describe the alternative feasible methods of providing electrical power to the subject facility. First cost, operating cost and maintenance cost, based on a 25-year facility life, shall be considered in selecting and recommending the optimum system. All appropriate design standards shall be incorporated into the analysis. All calculations and a clear and concise narrative supporting the recommendations shall be submitted as part of the economic analysis.

3.4.2. Considerations shall include 480/277 volt vs. 120/208 volt standard service systems; use of existing spare transformer capacity vs. providing new transformer; multiple vs. single transformers for multiple building complexes; alternative lighting systems (solar powered exterior lights, etc.); state-of-the-art design, etc.

3.4.3. Electrical analyses are required for the following types of projects:

a. Additions to or alteration of an existing facility.
b. New facilities.
c. New multiple facilities or building complexes.
d. Base-wide electrical distribution systems (Large utility projects).

3.4.4. Special Considerations. The minimum economical load for a 480/277-volt system versus a 120/208 volt system is approximately 200 KVA. The cost of secondary transformation and switch gear larger than this capacity at 208 volts is usually between 125% and 140% of the cost of a comparable 480 volt system. Systems larger than 200 KVA capacity would, in general, have a 480/277 volt, 3-phase, 4-wire KVA, a 480/277 volt service must be used. Dry-type, step-down transformers would be provided to grounded wye service for general power and lighting. For systems with capacity larger than 500 KVA derive power at 120/208 volt, 3-phase, 4-wire convenience outlets, incandescent lighting, bench power, small appliances, etc. For systems less than 200 KVA, the 120/208 volt, 3-phase, 4-wire grounded wye service for the entire building is generally more economical. The economic analysis may however disprove this in rare instances.

SECTION 4 ARCHITECTRUAL STANDARDS

4.1. GUIDING CRITERIA:

4.1.1. Governing Philosophy. Architectural solutions shall be aesthetically pleasing and consistent, conforming to given direction and providing a unified solution for the type of facility to be constructed. Architectural solutions shall avoid the appearance of grandiose design and shall avoid proposed elements that do not provide true value for the cost investment in the architectural feature.

Headquarters Operations and Training

Architectural themes for facilities shall present a cohesive base wide campus setting, with complimenting features and detail. Selection of materials, colors and architectural themes shall continue existing base standards, shall conform to the base's architectural master plan and the approved base master plan.

Multi Purpose Facility

Design and construction shall conform to quality commercial/industrial standards and shall provide a complete and usable facility. Standards established in the contract documents for construction workmanship shall be of the highest quality. It is especially important to select and specify finishes and surfaces that are durable and require minimal maintenance. Facility design and construction shall include all finishes, built-in equipment, casework, mechanical, electrical, security, safety, utility, landscaping, pavements, etc. as applicable to each specific project.

4.1.2. Designing for Disabled Persons.

4.1.2.1. All facilities shall be designed in accordance with ANG ETL 98-2 Compliance with Handicapped Accessibility Standards.

4.1.2.2. ANG facilities shall be designed and constructed to comply with Handicapped Accessibility Laws and Standards. ANG facilities and portions of facilities used exclusively by able-bodied military personnel as defined by the Uniform Federal Accessibility Standards (UFAS) (paragraph 4.1.4 (2) military exclusions) may be excluded. Facilities where other than able-bodied military personnel may work (state or civilian employees), that may be visited by persons conducting business (vendors), or that may be visited by people (the public) during special event days at a base, such as, career days, air shows, etc. shall comply with handicapped accessibility standards. These facilities include but are not limited to:

a. Operational Training / Headquarters Facilities
b. Base Civil Engineering Facilities
c. Base Supply and Equipment Warehouses except weapons storage and maintenance areas
d. Security Forces except weapons storage and maintenance areas
e. Multi-Purpose Facilities
f. Squadron Operations
g. Dining Facilities except food preparation training areas
h. Medical Training and Administration Facilities if medical treatment is provided
i. Other facilities based on the specific or unique requirements for that facility

4.1.2.3. The first floor of all other ANG facilities shall also be handicapped compliant. Other floors that meet the UFAS Military Exclusion test need not comply.

4.1.2.4. All site features associated with an accessible facility or public areas accessible by private vehicles shall comply.

4.1.2.5. Comply with handicapped parking requirements for accessible facilities including van accessible stalls. The number of handicapped stalls shall be based on non-military users of the facilities. Community-parking requirement shall govern for facilities made available to the community. Handicap spaces are not counted as part of the 75% UTA parking space allocation.

4.1.2.6. All signage within accessible buildings and areas shall comply with handicap accessibility requirements. Refer to American with Disabilities Act Accessibility Guidelines (ADAAG) instead of UFAS, which is the more restrictive.

4.2. EXTERIOR DESIGN:

4.2.1. The primary objective for exterior architectural standards is to develop a common and unifying architectural vocabulary that promotes high quality, cost effective and low maintenance construction. Exterior architectural design shall conform to the base architectural master plan or continue to develop existing base architectural themes and shall follow the base master plan.

Headquarters Operations and Training

Aircraft Maintenance Administration and Shops

4.2.2. Exterior design shall provide organized outdoor storage spaces, storage yards and work compounds. These spaces shall be secured and screened with sight proof / partially sight proof systems that match or compliment the facility architecture. Items such as dumpsters and mechanical/electrical/communications equipment shall be screened with materials that match and are an extension of the facilities architecture.

Civil Engineering Storage Compound

Vehicle Maintenance Storage Compound

HVAC Screen Wall

4.2.3. Standardize common construction components within each facility and also base wide, such as doors and door hardware, roofing, masonry, lighting, communication devices, etc. to the fullest extent possible. Coordinate requirements with contracting officials to avoid potential sole source procurement conflicts.

4.2.4. Provide designs that avoid construction of nooks, ledges and alcoves or points of egress that would encourage nesting or congregation of local wildlife.

4.2.5. Vertical Concrete Work. Finishes for concrete shall be appropriate to the area and intended use. All vertical cast concrete work shall have applied texture, or cast in place relief or pattern. Exposed unfinished foundations are not allowed. Color of finish concrete shall be coordinated with facility and base architectural colors. Concrete retaining walls shall be of sufficient thickness and reinforcement and shall be provided with sufficient construction and expansion joints to fully control cracking of the placed wall. Fully detail all concrete jointing on the contract plans. Jointing plans shall avoid creation of sections that are unusually narrow and/or that taper to a point. Provide sealed expansion joints between all vertical and horizontal concrete and masonry work.

4.2.6. Horizontal Concrete Work. Finishes for concrete shall be appropriate to the area and intended use. Concrete joints shall be pre-formed with tooled edge in building or site construction where the concrete surface will be exposed to view or subject to vehicle or pedestrian traffic. Sawed concrete joints are permitted elsewhere but must be provided with appropriate joint sealant. Joints shall be tooled or sawn to minimum 1/3 of slab thickness in all cases. Fully detail all concrete jointing on the contract plans. Excessively large expanses of concrete without joints are prohibited (greater than 3.1 meters by 3.1 meters (10 feet by 10 feet) generally). For airfield pavements, use a maximum of 6.2 meter by 6.2 meter (20 feet by 20 feet) panels. Jointing plans shall avoid creation of sections that are unusually narrow (narrower than 0.6 meters (2 feet) and/or that taper to a point.

4.2.7. Finishes Coordination. Develop facility and site exterior materials and color palettes and apply consistently throughout. Ensure that all items exterior to the facility such as but not limited to mechanical, electrical and communications equipment and materials are specified to have finishes selected from the developed facility or base color palette.

4.2.8. Facility and utility protection. Provide steel edge guards at all vehicle and equipment access doors into facilities. Also provide galvanized schedule 40 steel bollards that are concrete filled at appropriate equipment and vehicle access points into facilities, at exposed above grade utilities, within dumpster enclosures and all other locations requiring protection from accidental vehicle damage. Also, provide hot dipped galvanized steel edge cast integrally into the slab for all horizontal edges or corners such as loading docks, vehicle entrances into facilities and other similar use areas.

4.2.9. Exterior Facility and Site Signage.

4.2.9.1. Site and all facility signage shall follow base standard and shall be in conformance with the guidelines found in AF Pamphlet 32-1099 or equivalent base standard guideline. In order to accomplish a unified base appearance, it is essential that base signage systems be consistent and uniform in construction and colors.

Base Standard Facility Signage

4.3. INTERIOR DESIGN:

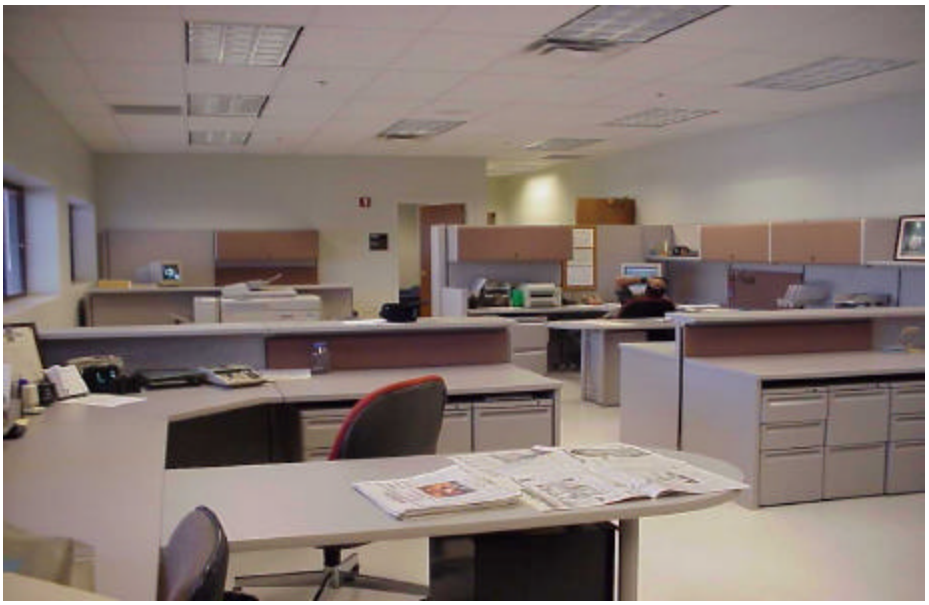
4.3.1. Authorized Office and Conference Room Sizes (maximum net square footage).

Wing/Air Commander	27.9 sq. meter (300 sq. foot) office 27.9 sq. meter (300 sq. foot) conference room
Squadron Commander	23.2 sq. meter (250 sq. foot) office 20.9 sq. meter (225 sq. foot) conference room
Colonel	23.2 sq. meter (250 sq. foot) office
Lt. Colonel	20.9 sq. meter (225 sq. foot) office
Major	16.3 sq. meter (175 sq. foot) office

Captain	13.9 sq. meter (150 sq. foot) office
1st or 2nd Lieutenant	11.6 sq. meter (125 sq. foot) office
First Sergeant (or E-9)	11.6 sq. meter (125 sq. foot) office
Senior NCO (E-7 or E-8)	9.3 sq. meter (100 sq. foot) office
Administrative Workstation	8.4 sq. meter (90 sq. foot) area
Shared Administrative Workstation	4.2 sq. meter (45 sq. foot) area each

4.3.2. Pre-wired Workstations.

4.3.2.1. Open office planning is required for all ANG facility Military Construction Program's (MCP) and major facility RPM projects. Use of open floor plans greatly enhances the usability and flexibility of available square footage in each facility. Pre-wired workstation systems (PWS) shall be accommodated by all new facilities and major renovations that are constructed in the RPM/MCP program with a minimum of 92.9 square meters (1,000 square feet) of contiguous administrative area. Floor-to-ceiling walls in administrative areas shall only be used for conference rooms, classrooms and supervisors' offices. Comply with the design requirements of ANG ETL 92-3, "Systems Furniture Management."



Open office with Pre-wired Work Stations

4.3.2.2. The A-E shall develop facility designs, including the PWS layout, up to the concept design submittal stage using generic workstation layouts to insure floor area is adequately sized to accept PWS systems. Pre-wired workstations procurement must be carefully coordinated with the facility design and construction. Purchase shall be made using base Operations and Maintenance (O&M) funds for all RPM and President budget MCP projects, as directed by ANG/CE. The final, vendor specific design and installation of the pre-wired workstations will be a separate procurement, generally made at the time when the facility construction is being procured.

Conference room adjacent to open PWS workstation area

4.3.3. Sound Control and Acoustics.

4.3.3.1. Special care shall be take to design and specify the proper materials for sound control in facilities. Those facilities facing airport flight line activity or other high noise environments shall have design consideration applied to limit exterior noise transmission into facility interiors, to appropriate decibel levels.

4.3.3.2. Interior spaces shall also be provided with room to room acoustical insulation for walls and ceilings. Areas include break rooms, conference rooms, training rooms, restrooms, offices, auditoriums and mechanical rooms. Additional areas would include separating industrial functions such as shops, from administrative functions. Provide acoustically improved partitions for division of conference and training rooms into smaller use areas.

4.3.3. Standardization. Standardize common facility construction components such as doors, door frames and door hardware, interior finishes and colors, lighting, registers, grills and louvers, water coolers, fire extinguisher cabinets, communication devices, etc. to the fullest extent possible. Standardize these same facility construction components between different base facilities to the fullest extent possible, taking into account contracting and procurement policy.

4.3.4. Signage. Facility interior signage shall follow base standard and shall be in conformance with the guidelines found in AF Pamphlet 32-1099 or approved base master signage publication. Signage shall be handicap accessibility compliant.

4.3.5. Finishes Protection. Provide full and adequate protection systems for interior finishes. These protection systems include stainless steel corner guards for circulation space wall corners, bumpers and stops at walls and doors for control of equipment, custodial service items, dollies, moving equipment and other items. Provide floor mounted door stops for all interior doors that do not have automatic closure mechanisms with travel limit adjustment. Provide door push plates and base kick plates as appropriate for the interior use and of the proper finish.

4.3.6. Typical Room Requirements. The following matrix describes typical features that are provided in rooms for all building use types. The intent is to establish consistency and uniformity between various facility types. The BCE shall accept indicated finishes or propose suitable equivalent alternatives. See Tab A of each facility for features in addition to those shown below:

ROOM TYPE											
ROOM FEATURES	**Offices**	**Break Room**	**Conference Room**	**Entry**	**Shops**	**Toilets**	**Training Rooms**	**Corridor Circulation**	**Storage**	**Janitor**	**Utility Room**
Base Intercom Speakers		X	X #	X	X	X	X	X #			
Building Directory & Signs				X				X			
Bulletin Boards		X			X		X				
CCTV Outlets/Brackets	X Per Base Policy	X	X				X				
Computer (LAN) Outlets @	X	X	X		X		X		X		X
Lighted Display Case and/or Wall Rack		X		X			X				
Emergency Eye Wash & Deluge Shower (As Required)					X		X				X
Liquid or Dry Erase Chalkboard	X	X	X		X		X				
Projection Screen			X				X				
Ceiling Mounted Projector *			X				X				
Refrigerator Space		X									
Telephone Outlet @	X		X		X		X		X		X
Vending Machine Space		X									
Vestibule				X							
Water Cooler		X			X			X			
Window Blinds	X	X	X	X	X		X	X	X		
Picture Mounting System			X	X			X	X			
Built in Casework		X	X				X				
Built in Storage Shelving					X				X	X	
Floor Drain					X+	X+				X+	X+

@ One per workstation minimum
# Switchable with volume control
+ See Section 10 for additional information
* Projector is provided as Government furnished Equipment.

4.3.7. Finishes for Administrative Spaces. The following matrix describes general finish requirements for typical spaces within ANG Administration facilities. The matrix is intended to offer standards typical to ANG construction. It is the BCE's responsibility to accept these finishes or propose suitable equivalent alternatives. Special requirements listed in Tab A supersede or add to these requirements.

SPACE NAME	FLOORS	BASE	WALLS	CEILINGS	MIN. CLG. HEIGHT	DOORS
Bathrooms/Lockers	CT*	CT	CT(W)E	GB	2.7m (9ft)	WD
Break Rooms	VCT	R	GB	AT	2.7m (9ft)	WD
Briefing/Conference	CPT	R	GB	AT/GB	Note 2	WD
Circulation	CPT	R	VWC	AT/GB	2.7m (9ft)	WD
Classroom	CPT	R	GB	AT	2.7m (9ft)	WD
Janitor	CT	R	CT(W)E	GB	2.7m (9ft)	WD
Labs (Film)	VCT*	R	GB	AT	2.7m (9ft)	WD
Audio Visual	CPT	R	GB	GB	4.3m (14ft)	WD
Offices	CPT	R	GB	AT	2.7m (9ft)	WD
Storage	VCT	R	GB	AT	2.7m (9ft)	WD
Vaults/Secure Rooms	VCT	R	CON	CON	2.7m (9ft)	MT
Entry/Vestibule	QT	QT	GB	AT/GB	2.7m (9ft)	SF
Dining Area	CPT	R	GB	AT	3.7m (12ft)	SF
Kitchen	QT*	QT	CT	GB	3.1m (10ft)	MT
Mechanical/Electrical	CON	N	CMU	ES	Note 1	MT
Serving Line	T	R	CT	GB	3.1m (10ft)	MT
Security Gate House	RF	R	GB	GB	2.7m (9ft)	MT/GL
Stairwells	RF	R	CP or GB	GB	N/A	MT/WD
Telecomm Closets	VCT	R	GB/PLY	GB	2.7m (9ft)	MT/WD

ABBREVIATION KEY:

FLOORS

CON Concrete
CPT Carpet
CT Ceramic Tile
QT Quarry Tile (Non-skid)
T Tile
VCT Vinyl Composition Tile
RF Rubberized Flooring

*Alternate floor to be seamless "quartzite" with integral seamless base.

CEILINGS

AT Acoustic Ceiling Tile
CON Concrete
ES Exposed Structure (Light Color)
GB Painted Gypsum Board

WALLS

CMU Painted CMU
CON Sealed Concrete
CT Ceramic Tile
ES Exposed Structure, Painted as Appropriate
GB Painted Gypsum Board
VWC Vinyl Wall Covering
E 2-Part Epoxy Coating
W Wainscot
PLY 3/4" Plywood, B-sanded face grade
CP Painted Cement Plaster

DOORS (PERSONNEL)

SF Storefront
MT Metal
WD Wood, Solid Core
GL Glass Sliding Door(s)

BASE

R 10.2cm (4") Rubber
CT Ceramic Tile
QT Quarry Tile

Note 1. Height as required for duct and equipment clearances.
Note 2. Ceiling height 3.7m (12ft) maximum, 2.7m (9ft) minimum, and proportional to room size and occupancy.

4.3.8. Finishes for Industrial Spaces. The following matrix describes general finish requirements for typical spaces within ANG Industrial facilities. The matrix is intended to offer standards typical to ANG construction. It is the BCE's responsibility to accept these finishes or propose suitable equivalent alternatives. Special requirements listed in Tab A supersede or add to these requirements.

SPACE NAME	FLOORS	BASE	WALLS	CEILINGS	MIN. CLG. HEIGHT	DOORS
Bathrooms/Lockers	CT*	CT	CT(W)E	GB	2.7m (9ft)	MT
Break Rooms	VCT	R	GB/VWC	AT	2.7m (9ft)	WD
Briefing/Conference	CPT	R	GB/VWC	AT/GB	Note 1	WD
Circulation	VCT	R	GB/VWC	AT/GB	2.7m (9ft)	WD
Classroom	VCT	R	GB/VWC	AT	Note 1	WD
Hangar Bay Maintenance Docks	CON-P	N/A	ES	ES	Note 2	MT
Janitor	CT	R	CT(W)E	GB	2.7m (9ft)	WD
Labs and Clean Shops	VCT*	R	GB	AT/GB	Note 2	MT
Mechanical/Electrical	CON	N/A	CMU	ES	Note 3	MT
Shops	CON-P	R	CMU	ES	Note 2	MT
Shop Offices	VCT	N/A	GB	AT	2.7m (9ft)	MT
Storage	CON	N/A	CMU	ES	Note 2	MT
Entry/Vestibule	QT	R	GB	AT/GB	2.7m (9ft)	SF
Shops A/C	VCT	R	GB	AT	3.1m (10ft)	WD
Warehouse	CON-P	N/A	CMU/ES	ES-P	Note 2	MT
Covered Parking / Docks & Storage	CON	N/A	N/A	PM/CP	N/A	N/A
Stairwells	RF	R	CP or GB	GB	N/A	MT/WD
Telecomm Closets	VCT	R	GB/PLY	GB	2.7m (9ft)	MT/WD

ABBREVIATION KEY:

FLOORS
CON Concrete
CPT Carpet
CT Ceramic Tile
QT Quarry Tile
VCT Vinyl Composition Tile
CON-P Concrete Painted w/Two Part Epoxy Coating
*Alternate floor to be seamless "quartzite" with integral seamless base.

CEILINGS
AT Acoustic Ceiling Tile
ES Exposed Structure (Light Color)
GB Painted Gypsum Board
PM Painted Metal Panel
CP Painted Cement Plaster
AT/GB Combination of AT and GB vary ceiling heights

WALLS
CMU Painted CMU
CON Sealed Concrete
CT Ceramic Tile
CP Painted Cement Plaster
ES Exposed Structure, Painted as Appropriate
GB Painted Gypsum Board
VWC Vinyl Wall Covering
E 2-Part Epoxy Coating
W Wainscot

DOORS (PERSONNEL)
SF Storefront
MT Metal
WD Wood, Solid Core

BASE
R 10.2cm (4") Rubber
CT Ceramic Tile
QT Quarry Tile

Note 1. Ceiling height 3.7m (12ft) max. 2.7m (9ft) min. proportional to room size and occupancy.
Note 2. See Tab A for each facility for program required ceiling heights.
Note 3. Height required for duct & equipment clearances.

4.3.9. Primary Entrances and Lobbies.

4.3.9.1. Primary facility entrances shall include double door entrances into a suitably sized air lock type vestibule prior to entering into the main building lobby. This will facilitate energy conservation for the facility. Provide recess door mat and high quality slip resistant tile or other suitable floor finish within the entrance area and lobby. Ceilings in the entry, vestibule and lobby area shall generally be higher in height and use combination of drywall and architectural acoustic tile with varying ceiling heights. Provide multi event lighting with general area lighting and recessed spot or area lighting as well. Provide picture mounting rails, lighted wood and glass display cabinetry and case work, building directory and other quality entrance features. Due to location or layout, some facilities may require multiple primary entrances.

4.3.10. Restroom's and Locker Room's.

4.3.10.1. Provide all restroom/locker areas with slip resistant floor tile and as a minimum tile wainscot with painted surface and hard ceiling above. Wall tile work shall be detailed to frame items such as dispensers, lockers and mirrors. Include color and patterns in floor and wall tile. Sink areas, counters and other wet surfaces, shall be constructed of solid surface materials for durability. Fixtures such as urinals and water closets shall be wall mounted, vitreous china with automatic flush. Partitions shall be durable metal or solid surface and shall be ceiling or wall mounted with heavy duty hardware. All bathroom and locker areas shall be provided with floor drains with primer. Provide a minimum of one semi-recessed stainless steel towel dispenser and trash fixture for every two water closets. Provide stainless steel framed wall or fixture mounted mirrors above all sinks. For restrooms with two or more sinks at one area, provide a single large stainless steel framed wall-mounted mirror. Provide a minimum of one full height, uniform check mirror in each restroom and locate at the restroom exit. Provide all stainless steel accessories for rest rooms including dispensers, holders, grab bars, hook's, etc. Provide coat and hat rack as well as stainless steel shelving for temporary storage of items while using facility. Locker rooms shall generally be co-located with restroom areas and shall have cross circulation with the restroom as well as independent entrances. Lockers shall be secured to the wall and shall be mounted on solid cove tile base approximately 15.2 cm (6 inches) above floor level. Lockers shall have louvers and slant metal top. It is recommended that full height 1.8 meter (6 foot) lockers with integral shelf and clothes hanger be specified. Provide built-in bench seating in all locker areas. Avoid creating dead spaces or unused corners with locker system layouts. Area lighting shall be use motion sensors and shall include recess and soffit lighting over sinks and urinal areas as well as fluorescent general room lighting.

4.3.10.2. For designing toilet facilities use 80% male and 20% female ratio in the absence of specific data.

4.3.11. Break Rooms.

4.3.11.1. Break rooms shall typically be provided for each ANG facility. It is strongly recommended that co-used break rooms be developed in composite type facilities, with central access from the facility. Break rooms shall be provided with finishes and appurtenances as indicated in the previous matrices. It is recommended that break rooms be located such that direct access to the facility exterior can be achieved from the break area. An appropriately sized exterior patio should be developed adjacent to the break room. Where possible, it is recommended that the exterior patio area be partially covered by development of the roofing element and also be partially open air. Appropriate masonry screen walls, landscaping and lighting shall be provided.

4.3.11.2. Provision of amenities for break rooms may include sinks, capability for placement of coffee makers, microwaves ovens, vending machines and refrigerators.

4.3.11.3. Provision of convection ovens, stoves, griddles or similar cooking devices for break rooms in other than primary duty fire crash/rescue stations and alert facilities is strictly prohibited.

4.4. GENERAL:

4.4.1. Mechanical Areas. Provide sound proofed masonry walls continuous to deck above at all mechanical rooms. Boiler, furnace, chiller and AHU rooms shall have double door, exterior entrances only.

4.4.2. Structural. Designs shall use structural steel and masonry/concrete for all structural building components. Roof framing systems shall maximize the usability of the ceiling plenum area for installation of other facility systems such as mechanical equipment and systems, communications and electrical. Use of wood as a structural material is prohibited.

4.4.3. Ceiling Heights and Structural System Heights. Generally, provide a minimum of 0.9 meters (3 feet) of clear space between all gypsum or acoustical ceilings and the underside of facility structural members. This clear space is reserved for the installation of mechanical, electrical and communications systems.

4.4.4. Accessibility for Maintenance. Design of ANG facilities shall ensure that adequate space and accessibility is built in for the proper maintenance and operations of the facility. Provide adequate space in all mechanical, electrical and communications rooms for installation and access of all equipment. Provide access panels and doors wherever equipment is installed. Generally, provide service platforms/catwalks and access stairs whenever items are mounted over 2.1 meters (7 feet) above grade. Designs shall include provision of knock out walls, oversized removable louvers or other methods to facilitate future equipment replacement. In no instance shall designs mandate that equipment must be placed prior to construction of the surrounding walls and roof.

4.4.5. Concrete Work. Finishes for concrete shall be appropriate to the area and intended use. Concrete joints shall be pre-formed with tooled edge in building or site construction where the concrete surface will be exposed to view or subject to vehicle or pedestrian traffic; sawed joints are permitted elsewhere. Joints shall be tooled to minimum 1/3 of slab thickness in all cases. Fully detail all concrete jointing on the contract plans. Jointing plans shall be developed such that failure and cracking of concrete at locations other than at the jointing is avoided in all cases. Excessively large expanses of concrete without joints are prohibited (greater than 3.1 meters by 3.1 meters (10 feet by 10 feet) generally). For airfield pavements, use a maximum of 6.2 meter by 6.2 meter (20 feet by 20 feet) panels. Jointing plans shall avoid creation of sections that are unusually narrow and/or that taper to a point. Provide sealed expansion joints between all horizontal concrete and any vertical construction element.

4.4.6. Floor slabs in aircraft service bays (hangar, fuel cell, corrosion control, etc.), vehicle maintenance bays, and POL lab rooms shall be 15.2 centimeters (6 inches) lower than adjacent shop and administrative areas. Additional hangar floor information is also found in Section 8 of this Tab, AIRFIELD PAVEMENTS AND HANGAR FLOORS.

4.5. DESIGNING FOR FORCE PROTECTION: Design of ANG facilities and ANG Site's shall follow the most recent ANG Force Protection policy as published.

4.6. SCOPE CALCULATION: All facility space allowances are expressed in terms of gross area, unless noted otherwise. Gross area shall be calculated to the outside of enclosure walls. For scope calculations, the following guidance applies:

4.6.1. Include full area for basements with 2.4 m (8 feet) head clearance, all above grade floors, permanently affixed mezzanines, mechanical equipment (heating/utility) rooms, penthouses, enclosed passages, walks, porches and balconies. Also include full area for totally enclosed raised loading platforms.

4.6.2. Include one-half area for covered but not fully enclosed slabs, entries, passages, walks, porches and balconies. Also include one-half area for uncovered raised loading platforms and covered or uncovered depressed (below grade) loading facilities.

4.6.3. Exclude areas for roof overhangs, utility tunnels, all exterior or interior stairs and stair wells and elevator shafts. Exclude exterior uncovered walks, ramps, stoops and paved terraces. Exclude enclosed spaces having a maximum ceiling height of 2.1 meters (7 feet) or less and exclude hangar door pockets for roll back doors. Exclude mezzanines that provide utility, mechanical or other direct support requirements for the facility. Exclude mezzanines that are of a moveable nature (skid mounted or on wheels) and that have been placed on the supply records.

4.6.4. Scope Demonstration. The A-E shall clearly show all space and scope calculations on architectural sheets and shall include graphics to indicate what areas are calculated as full scope, half scope and/or excluded from scope calculations. Include graphics to indicate the functional areas which are broken out in the program document (DD Form 1391). Provide a graphics keyed table which shows the DD Form 1391 functional area requirement(s) scope versus the actual design square meters (footage(s)) for each functional area. All functional areas shall be calculated as sub totals and expressed as gross square meters (footages). Provide total project DD Form 1391 scope versus design total square meter (footage) calculations expressed as gross square meters (footage). Provide calculation of the project net square meters (footage). Provide calculation of the ratio of gross to net space. Provide calculation of the percentage of net scope that is used for circulation space versus net total design square meters (footage). Provide all information required as part of the 35% submission.

4.7. NONCOMBUSTIBLE CONSTRUCTION: ANG facilities and infrastructure shall be designed and constructed using noncombustible materials as defined by Type I and Type II construction of the 2000 International Building Code, except as modified herein. Fire retardant treated wood in partitions, exterior non-bearing walls and roof construction as permitted by the IBC in paragraphs 603.1.1 and 603.1.8, Section 603 Combustible Materials in Type I and II Construction, is prohibited in ANG construction.

SECTION 5 DESIGN CRITERIA ON HEAT TRANSMISSION FACTORS

5.1. INTRODUCTION:

5.1.1. The design U-values, or overall heat transmission factors, for roofs, walls and floors shall not be greater than those set forth below for any ANG facility construction. Heating Degree Days (HDD) and Cooling Degree Days (CDD) are relative to a 47.2° Centigrade (65° Fahrenheit) baseline. In facilities or portions of facilities that are authorized both heating and cooling systems, the U-values selected shall be the lower of those shown.

5.1.2. Lower U-values (higher R-values) shall be considered for ANG facility construction, provided an A-E study is performed to show economic feasibility. The study should take into account the additional installed costs and energy escalation values and shall indicate the number of years for "simple payback."

5.2. U-VALUES FOR HEATED BUILDINGS:

5.2.1. Facilities heated to a minimum of 47.2° Centigrade. (65° Fahrenheit)

	HEATING DEGREE DAYS (HDD)				
	10,000 and More	8,000 - 9,999	6,000 - 7,999	4,000 - 5,999	3,999 and Less
ROOFS	0.03	0.04	0.04	0.05	0.05
WALLS	0.05	0.05	0.06	0.08	0.10
FLOORS overhanging or over unheated areas	0.04	0.05	0.06	0.07	0.09

5.2.2. Facilities heated from 37.2° Centigrade to 46.2° Centigrade. (55° Fahrenheit to 64° Fahrenheit)

	HEATING DEGREE DAYS (HDD)				
	10,000 and More	8,000 - 9,999	6,000 - 7,999	4,000 - 5,999	3,999 and Less
ROOFS	0.04	0.05	0.06	0.06	0.07
WALLS	0.06	0.06	0.08	0.10	0.12
FLOORS overhanging or over unheated areas	0.06	0.06	0.07	0.08	0.10

5.2.3. Facilities heated from 22.2° Centigrade to 36.2° Centigrade.
(40° Fahrenheit to 54° Fahrenheit)

	HEATING DEGREE DAYS (HDD)				
	10,000 and More	8,000 - 9,999	6,000 - 7,999	4,000 - 5,999	3,999 and Less
ROOFS	0.06	0.06	0.07	0.08	0.10
WALLS	0.08	0.08	0.10	0.12	0.14
FLOORS overhanging or over unheated areas	0.08	0.08	0.10	0.10	0.12

5.3. U-VALUES FOR AIR-CONDITIONED BUILDINGS:

5.3.1. Facilities cooled to a maximum of 52.2° Centigrade and 50% relative humidity.
(70° Fahrenheit and 50% relative humidity)

	COOLING DEGREE DAYS (CDD)				
	3,000 and More	2,250 – 2,999	1,500 – 2,249	750 – 1,499	749 and Less
ROOFS	0.04	0.05	0.05	0.06	0.07
WALLS	0.06	0.07	0.07	0.08	0.09
FLOORS (which overhang or are over uncooled areas)	0.05	0.06	0.06	0.07	0.08

5.3.2. Facilities cooled to a maximum of 57.2° Centigrade and 60% relative humidity. (75° Fahrenheit and 60% relative humidity)

	COOLING DEGREE DAYS (CDD)				
	3,000 and More	2,250 – 2,999	1,500 – 2,249	750 – 1,499	749 and Less
ROOFS	0.05	0.05	0.06	0.07	0.08
WALLS	0.07	0.07	0.08	0.09	0.10
FLOORS (which overhang or are over uncooled areas)	0.07	0.07	0.08	0.09	0.10

5.3.3. Facilities cooled to a maximum of 62.2° Centigrade and 60% relative humidity. (80° Fahrenheit and 60% relative humidity)

	COOLING DEGREE DAYS (CDD)				
	3,000 and More	2,250 – 2,999	1,500 – 2,249	750 – 1,499	749 and Less
ROOFS	0.06	0.07	0.09	0.09	0.10
WALLS	0.08	0.09	0.10	0.10	0.12
FLOORS (which overhang or are over uncooled areas)	0.08	0.08	0.09	0.10	0.12

SECTION 6 ROOFING

6.1. WARRANTIES: Roofing system designs for new roofs and total roof replacements shall require the following minimum warranty provisions:

Manufacturer's 30-year warranty (minimum) for shingle systems.
Manufacturer's 20-year warranty for built-up roofing (BUR) systems.
Manufacturer's 20-year warranty for standing seam metal roof systems.
Manufacturer's 15-year warranty (minimum) for all other systems.

6.1.1. Warranties shall cover all materials and all labor to correct leaks and other defects with a limit of the full installed cost of the roof system. The rationale for purchasing a warranty is to obtain assistance from the roofing system manufacturer to ensure the roofing system is installed correctly during construction. Designers shall require roofing system manufacturers' best warranty. This is the type of warranty for which the manufacturer usually requires the roofing system installer to be certified or otherwise pre-qualified by specified training and experience. The prerequisite for the warranty will also usually require one or more inspections by a roofing system manufacturer's representative before, during and after roofing system installation.

6.1.2. Assistance is often available to the designer during the concept or investigative stage. During the concept stage roofing manufacturers will readily provide input for avoiding problem conditions such as inside corners, valleys, dormers or cascading water (water falling from one roof surface to another). Where problem conditions cannot be avoided, they will provide special details.

6.1.3. Overlay replacement roof designs shall require a manufacturer's warranty consistent with the industry norm for the type of roof being designed, but not less than 10 years. In some cases, this warranty will be the same as the warranty for a new roof system.

6.2. DESIGN CRITERIA:

6.2.1. General. Water shedding (pitched roof) systems are preferred and must be considered over low-sloped, waterproof systems for all new facilities and roof replacement projects. Water shedding systems are those systems with a minimum slope of 25 centimeters per meter (3 inches per foot). ANG policy is to require the use of standing seam metal roof systems wherever feasible. Some ANG facilities, because of size, may not be conducive to water shedding systems. Whenever this is the case, the A-E shall communicate, in the Concept submittal, how a pitched roof system was considered and the rationale which led to recommending a low-sloped, waterproof roof system.

6.2.2. Low-Sloped Roofing. Whenever low-sloped waterproof systems are used, the following design criteria must be followed:

6.2.2.1. Do not introduce new membrane systems to the installation without consulting the Base Civil Engineer, providing rationale for the selected system in the Concept submittal.

6.2.2.2. Ensure the system to be specified is manufactured by firms having the experience, background and financial resources necessary to meet the warranty provisions noted above.

6.2.2.3. Further, the designer must investigate and verify the availability of the specified system to the region of the project site. See ANG ETL 93-4 for ANG roof design policy.

6.2.3. Standards. All roofs must meet Underwriters Laboratories, Inc., UL 790, Class A requirements for fire resistance and, as a minimum, Factory Mutual 1-90 or Underwriters Laboratories 580, Class 90 requirements for wind uplift resistance. Design for higher wind uplift resistance when required based on the most recent version of ASCE 7. For uplift resistance greater than 1-90 and for attachment at corners and perimeters, design the system to meet ASCE 7 requirements with a factor of safety of 2 applied. Waivers from ANG/CE require special justification. Design details shall be sufficient to fully define the work (including fastener or clip density at corners, perimeter and field of the roof, edge nailers; roof drains; curbs and penetrations). Use the latest edition of the National Roofing Contractors Association (NRCA) Construction Details, or roofing system manufacturer's details as approved by ANG/CE or other recognized standard details as approved by ANG/CE.

6.2.4. Energy. New construction shall achieve the maximum U-values (minimum R-values) listed in Section 5 of this Tab, "DESIGN CRITERIA ON HEAT TRANSMISSION FACTORS." These values shall also be met for all roof repair/replacement projects.

6.2.4.1. All roofs shall be designed as a "cool roof" where it is cost effective to do so and when appropriate products are available.

6.2.5. Drainage. In new construction, and where practicable in roof repair projects, provide a final, minimum slope of 4.2 centimeters per meter (1/2 inch per foot). For coal tar roof designs provide a final minimum slope of 1.0 centimeters per meter (1/8 inch per foot). Final minimum slope shall be calculated after allowing for roof deflections, which will occur after construction. Slope the structural framing or deck by varying column heights, truss elevations, etc. Show key elevations for top of roof framing members or concrete decks on the structural roof plan. Provide saddles between drains and crickets on the high side of curbed openings or other obstacles to divert water. Interior drainage systems are preferred over exterior drainage systems, especially in cold climates. Where exterior drains are expected to experience freezing weather, they shall be designed for maximum sunlight exposure.

6.2.5.1. All roofing design shall accommodate and control roofing drainage in a positive manner. No roofing design shall allow sheet flow from roofs onto adjacent grade without providing drainage control.

6.2.5.2. Interior drainage systems. Ensure that all drains move with the roof deck. Locate interior drains at mid-spans and at low points of the roof slopes. Avoid placing drains close to columns, bearing walls or other supports. Provide at least two cast iron manufactured drains for each roof area. The maximum allowable spacing between drains is 22.8 meters (75 feet). Provide additional drains for irregularly shaped roofs with obstructions. Provide separately plumbed overflow drains or scuppers where ponding could occur if the primary drain becomes blocked. Provide sumps at drains, recessing drain heads below the adjacent roof surface and tapering insulation a minimum of 0.6 meters (2 feet) from drain to edge of sump. Provide all drain inlets with strainers. Extend roof membrane, 1.8 Kilogram (4-lb.) lead flashing and strip flashing under the drain bowl clamping ring. Maintain a minimum distance of 0.3 meters (1 foot) from the strainer to any seam. Avoid interior gutters.

6.2.5.3. Exterior drainage systems. Design a gutter's highest vertical section at least 2.5 centimeters (1 inch) below roof height. Provide overflow scuppers in parapets at a maximum height of 5.1 centimeters (2 inches) above the primary roof drains.

6.2.5.4. Sizing. Use 100-year storm criteria from either the International Plumbing Code or Factory Mutual Loss Prevention Data Sheet 1-54, Roof Loads for New Construction.

6.2.6. Penetrations. Do not locate antennas, air conditioners, air-cooled condensing units, cooling towers and ductwork on roofs. Waivers from ANG/CE require special justification. Provide wall mounted antenna brackets that extend past the roof eave in lieu of roof mounted antenna supports. Provide adequate communication conduit with weather-head access to all wall mounted antenna brackets and/or roof areas for current and future communication mission changes. Require that all necessary penetrations be trade coordinated. All penetrations for standing seam metal roofing systems shall be centered on the roofing deck between structural members and roofing panel seams.

6.2.6.1. Equipment that is approved for roof placement shall have equipment supports that penetrate the roofing system with round shapes (pipe penetrations). Tie all equipment supports into the roofing structure below the roofing system. Provide an independent equipment support structure above the roofing system, which is attached to the pipe supports. Locate the equipment support system sufficiently above the roofing system as to allow for roofing system access for maintenance and replacement. Equipment shall be raised above the roof surface as indicated in the NRCA construction details. Ensure that all equipment support penetration flashing extends a minimum of 20.3 centimeters (8 inches) above the finished roof surface and provide a manufacturer's standard galvanized umbrella cap with clamping band, above the flashing system.

6.2.6.2. Minimize use of roof penetrations to the greatest extent possible. Use wall penetrations instead of roof penetrations whenever possible.

6.2.6.3. Do not allow penetrations of any kind, or runs of pipes, within one foot of any edge, expansion joint or control joint. To ensure proper clearances between base flashing and penetration flashing, the minimum distance between penetrations, walls and parapets may need to be greater than 0.3 meters (1 foot).

6.2.6.4. Maintain proper clearance between penetrations to allow for flashing installations and do not install penetrations in valleys or near drains or scuppers. Maintain a minimum distance of 0.3 meters (1 foot) between penetrations.

6.2.6.5. Use crickets, saddles and tapered edge strips, to direct water away from penetrations and parapet walls. Provide twice the field roof slope to ensure these surfaces are sufficiently sloped.

6.2.6.6. Assure all penetrations and their flashing extend a minimum of 20.3 cm (8 inches) above the finished roof surface. Base flashing along walls, parapets and expansion joints require the same minimum height.

6.2.6.7. Utilize flashing systems that can be maintained without disturbing adjacent building elements. Wall flashing (headwall and sidewall) shall use permanently installed reglets and detachable counter-flashing. Equipment curb flashing shall also use permanently installed flashing with detachable counter-flashing. Follow NRCA details for these flashing requirements.

6.2.6.8. All piping and conduit supports shall be the non-penetrating pillow block type or shall use support rollers that are specifically designed for this purpose and are compatible with the roof system.

6.2.6.9. All piping and conduits that must penetrate the roofing system, shall be provided with penetration flashing that extends a minimum of 20.3 centimeters (8 inches) above the finished roof surface. Penetration flashing shall be provided with a manufacturer's standard galvanized umbrella cap with clamping band of the proper diameter above the standard roof flashing system.

6.2.6.10. Pitch Pans. Use of pitch pans or pitch pockets are prohibited. If unavoidable, discuss with ANG/CE and allow for provision of pitch pocket with metal covers in accordance with NRCA construction details. As an alternative, provide a metal umbrella cap (per NRCA detail) clamped to the penetration.

6.2.7. Roof Access. Provide wide traffic pads, which are 2.5 centimeters (1-inch) thick neoprene or equivalent, for walking surfaces from the roof access point, to and completely around all equipment.

6.2.7.1. Interior Access. Wherever possible, provide access to roof areas from roof hatch with ladder (preferably from electrical or mechanical room) or stair enclosure with penthouse. Provide security to prevent unauthorized access to roof areas.

6.2.7.2. Exterior Access. After providing access to the lowest roof surface from the interior, provide access to higher roof areas, which are less than 7.6 meters (25 feet) above adjacent surfaces, by providing a fixed exterior caged ladder. Design the ladder top to prevent damage to roof edgings, parapet copings, roof base flashing and inside parapet wall finishes when accessing the roof. Ladder design shall comply with OSHA and AFOSH safety criteria.

6.2.8. Roofing Visual Impact. Carefully consider the selection of roofing materials and roofing details with respect to the visual impact of those materials and details. One example of an area where this is of critical importance is when providing low slope roofing on single story portions of a facility, which also has a two-story component. Another example would be construction of a single story facility that is overlooked by an adjacent two-story facility. Consider how the single story roof material and/or parapet will look from office views in the second story facility component. Also consider roofing materials for conformance with the installation's standard roofing color palette and details of construction.

6.2.9. Metal Roofing. Metal roofs for all buildings larger than 929 sq. meters (10,000 sq. feet) shall be Standing Seam Metal Roofs (SSMRs). SSMR systems can be used for slopes of 4.2 centimeters per meter (1/2 inch per foot) or greater. Highly corrosive environments require a minimum slope of 8.3 centimeters per meter (1 inch per foot) and a non-metallic finish. SSMRs shall not be designed where there is inadequate drainage or where valley gutters are required to drain the system.

6.2.10. Single Ply Roofing. This system can be used for slopes of 4.2 centimeters per meter (1/2 inch per foot) and greater. (Note: Less than 4.2 centimeters per meter (1/2 inch per foot) slope is not permitted on new construction even though some manufacturers may claim their products can be used at these slopes.) Fully adhered systems are preferred over mechanically attached or ballasted systems. See ANG ETL 91-5, "Shattering of Aged Unreinforced Polyvinyl Chloride (PVC) Roof Membranes."

6.2.11. Built-up Roofing. This system can be used for slopes of 4.2 centimeters per meter (1/2 inch per foot) to 25 centimeters per meter (three inches per foot). Note: Less than 4.2 centimeters per meter (1/2 inch per foot) slope is not permitted on new construction. The only exception is for coal tar roofs, which may be designed for 1.0 centimeters per meter (1/8 inch per foot) slope, which requires gravel surfacing.

6.2.12. Shingle Roofing. Shingles shall be used in limited and justified applications for slopes of 33.3 centimeters per meter (4 inches per foot) or more.

6.3. DRAWINGS: Roofing drawings shall include a complete roof plan for each building, showing the following as a minimum:

6.3.1. Building line and roof edge relation, roof slope and direction, a modular grid or structural column grid with number and letter coordinates, HVAC penetrations, equipment, pipe and conduit curbs, all roof drainage devices and all roof accesses. Provide a note to indicate the fire classification and wind uplift resistance the roof was designed to withstand. Include a note to indicate which design standard was used to determine wind uplift resistance.

6.3.2. Complete details for typical and unusual roof and building design conditions. Details shall be shown at 1/4 scale and may be shown in isometric projection. Details shall include, but not necessarily be limited to, metal roof edgings, roof edging joint covers, roof edging corners, transitions from expansion joint covers to roof edgings, area dividers (separating roof areas where the building or structural decking changes direction), control joints (joints to relieve membrane stresses for lengths over 61 meters (200 feet)), expansion joints (joints over through-building expansion joints), roof access hatches with ladder details, exterior roof access ladders, skylights, roof drains, roof overflow scuppers, hot and cold stacks, HVAC equipment curbs, pipe and conduit curbs, parapet wall and abutting building wall base flashing/counter-flashing, parapet caps or copings with joint details, gutters and downspout details.

6.3.3. For metal roofing systems, drawings shall clearly show the requirement to coordinate all trades with the roofing system. All penetrations shall be symmetric with respect to the roofing seams and panel centered. In addition, for open framing structural SSMR systems, the structural drawings shall include a note stating that shop drawings shall be based on the selected roofing manufacturer's specified clip density at corners, perimeters and field of the roof.

6.4. SPECIFICATIONS: Roofing specifications shall be explicit, definite, clear and enforceable at the time of construction. As in all specifications, their meaning and intent shall also be clear.

6.4.1. Specifications shall require that the contractor furnish a manufacturer-issued warranty as noted above as a prerequisite to final inspection and prior to final payment.

6.4.2. Specifications shall require that the contractor provide a metal warranty placard (0.6m by 0.6m (2ft by 2ft)) which clearly provides all information pertaining to the roofing system, including but not limited to, manufacturers, suppliers and contractors names, addresses and phone numbers, date of roofing installation and duration of roofing warranty. This professionally prepared graphics plaque shall be permanently mounted at each roof access location. The plaque shall be of color, font and type that is compatible with base architecture and signage standards.

6.5. ROOF REPAIR AND REPLACEMENT PROJECTS:

6.5.1. Existing roof composition, materials and attachment must be positively identified and their condition assessed for suitability to accept, and compatibility with, repair or reroofing materials to be used. Design field investigations may require destructive and non-destructive testing (i.e., core sampling, fastener pull tests, moisture survey and evaluation, etc.). Investigations shall identify existing system composition and thoroughly evaluate existing conditions, noting wet and damaged materials. All roof removal projects shall identify compositions that contain asbestos and the corresponding specification shall address special handling procedures.

6.5.2. Do not design a new roofing membrane over an existing membrane system. Exceptions may be approved by the Base Civil Engineer after design field investigation findings have been submitted and reviewed as part of the Concept submittal process.

6.5.3. For reroofing work, final system selection must consider the interaction and relationship of roof and facility materials, characteristics, conditions, environment, ease of maintenance and life cycle costs.

6.5.4. For roof replacement designs, ensure the existing structure in combination with the new roof system design can attain the required structural integrity, the specified fire rating and, where required, lightning protection.

6.5.5. Heights of existing penetrations, parapet walls and thickness of existing insulation must be considered and addressed in the design of reroofing projects. If tapered insulation is to be used, determine how it will effect the existing penetrations, expansion joints, parapet walls, adjoining roof sections and roof-mounted equipment.

6.5.6. Always design for using new metal in reroofing work (i.e., cap flashing, edge metal, drains, etc.) unless it can be assured that components can withstand removal, re-installation, or resetting without bending of or damage to the metal so as to perform their intended function. Materials whose condition will be deteriorated, whose condition will affect membrane warranty, or whose cost to remove and reinstall approaches or exceeds the cost of new installation shall be replaced with new metal.

6.5.7. Construction contract specifications shall require the contractor to notify the Contracting Officer when the existing roof system has been removed to allow time to conduct a full evaluation of decking before placement of new system begins.

6.5.8. Provide design that clearly details installation requirements for flashing systems that can be maintained without disturbing adjacent building elements. Flashing systems shall use permanently installed reglet or base flashing and counter-flashing assembly with a detachable counter-flashing component. Follow NRCA typical details.

6.5.9. Existing pitch pans or pitch pockets that remain as a part of construction, shall have new metal covers provided in accordance with NRCA construction details or shall have a metal umbrella cap clamped to the penetration.

SECTION 7 LANDSCAPING

7.1. GENERAL: The designer shall provide landscaping design that is both commensurate with the building's function and complementary to the facility architecture. Great emphasis is to be placed on using landscaping that requires minimal or no maintenance. Landscaping shall be appropriate to the climate and environment at the base. Landscaping shall use plants and materials that are indigenous and typical for the local area. The landscaping provided shall supplement the energy efficiency of the building through wind control, temperature modification, shading and glare / reflection reduction. Landscaping shall also be used as a tool for reducing noise and controlling erosion. Landscaping shall be used to screen or reduce visual impact of items that detract from the base appearance.

Static Display with Hardscape and Landscape Features Hardscape Retaining Walls (Above)

7.1.1. The entire building site shall be addressed on dedicated landscaping plan sheets. It is encouraged that the landscaping design be developed in such a manner that the landscaping requirements can be bid as Additive Bid Items in successive levels of completeness.

7.2. LANDSCAPE STANDARDS: Base landscaping shall be proportional to the facility function and location on the base. In general, landscaping requirements are divided into two zones, the administrative zone and the industrial zone. A hierarchy of landscaping levels of quality and intensity shall be developed for base designs. Base entrances and facilities such as Headquarters, Operations and Training, Squadron Operations and similar facilities shall have the highest level of landscaping intensity. Facilities such as Vehicle Maintenance, POL and Hush Houses should have appropriate, but lower levels of landscaping intensity.

7.3. INTERIM TRASH STORAGE: Dumpsters are the accepted method of trash handling for ANG facilities and appropriate capacity units must be positioned near each facility. For this reason, the facility site plan shall establish the dumpster location with appropriate architectural treatment that integrates the dumpster into the overall site plan. Architecturally compatible screen walls and landscaping shall be provided to minimize the visual impact but not obstruct services. Provide concrete base within the enclosure. Locate 15.2 cm (6 inch) concrete filled bollards at the back, sides and at the entrance of the enclosure to protect construction features. It is also recommended that concrete extend approximately 1.5 meters (5 feet) in front of the enclosure and that metal gates be provided as appropriate and per base standard requirements.

7.4. HARDSCAPING: Hardscaping is also considered part of the landscape development and shall be appropriate to the facility. Provision of wide sidewalks, patios, courtyards, planters, seating areas, pavilions, screen walls, retaining walls and similar construction shall be accommodated in the landscaping design.

7.5. VISUAL SCREENING: In order to provide an orderly and professional appearance for ANG facilities all aboveground utilities and construction shall have visual screening and be located to minimize their visual impact. Place items such as HVAC equipment, generators, electrical equipment and other related items to the sides or back of facilities. Items to be screened include, but are not limited to features such as:

- transformers and switchgear
- meters (all utility)
- condensing units, heat pumps and water cooling towers
- backflow preventers
- piping, pumps and all other HVAC equipment
- exhaust and ventilation equipment
- generators
- fuel tanks
- other elements
- Communication equipment such as satellite dishes and antenna

Trash Dumpster Enclosure HVAC and Plumbing Screen Wall (Above)

Visual screening shall be developed as an extension of the facilities architecture and shall utilize the same or complimentary materials as used in facility construction. Landscaping shall also be used in and around the screened areas to soften and blend the utility requirements into the facility appearance.

SECTION 8 AIRFIELD PAVEMENTS AND HANGAR FLOORS

8.1. CRITERIA:

8.1.1. Planning. AFMAN 32-1123(I) "Airfield and Heliport Planning and Design."

8.1.2. Paint Striping. Reference AFI 32-1042 "Standards for Marking Airfields." Use with AF ETL 94-1 "Standard Airfield Marking Schemes."

8.1.3. Shoulders and miscellaneous pavements in the flight line area shall be designed to support a 4536 kilogram (10,000 pound) single wheel load with a tire pressure of 292.6 kilograms per centimeter squared (100 p.s.i.).

8.1.4. Design.

8.1.4.1. Airfields.

8.1.4.1.1. Use Air Force mixed traffic design curves provided in the ANG Pavements Guide Statement of Work for airfield pavements on ANG property. Federal Aviation Administration (FAA) design curves may be used, where applicable for pavements used jointly with civilian aircraft off of ANG property. Pavement design shall be in accordance with AFM 88-6, Chapter 2, "Flexible Pavement Design for Airfields," or Chapter 3, "Rigid Pavements for Airfields." Computer aided design programs which comply with these standards are available for downloading at the PCASE (Pavement-Transportation Computer Assisted Structural Engineering) web site at www.pcase.com.

8.1.4.1.2. Approach Aprons to Hangars. Design approach aprons with the same design criteria as the hangar floors.

8.1.4.1.3. Hangar Doors. Provide rigid or asphalt pavements for the full width of hangar doors to a minimum distance of 9.1 meters (30 feet).

8.1.4.2. Hangar Floors.

8.1.4.2.1. Floors for hangars with doors larger than 39.6 meters (130 feet): The center floor area for maintenance hangars shall be rigid pavement, designed for medium load pavement, Type C traffic area, with remaining floor area designed for light load pavement, Type C traffic area in accordance with AFM 88-6, Chapter 3.

8.1.4.2.2. Floors for hangars with doors smaller than 39.6 meters (130 feet): The entire floor shall be rigid pavement, designed for light load pavement, Type C traffic area. Alert hangars and aircraft shelters shall be designed on an individual basis.

8.1.4.2.3. Shop and Administrative Floors. Administrative and shop floors shall be 15.2 cm (6 inches) higher than the immediately adjacent hangar bay floor. Egress points shall be provided with appropriate sloped integral concrete ramps from the hangar bay into the adjacent areas. Floors shall be designed for a load of 126390 kilograms per centimeter squared (300 p.s.f.) consisting of a minimum 15.2 cm (6-inch) PCC with 6 x 6, w2.4 x w2.4 welded wire fabric.

8.1.4.2.4. Hangar bay floors shall slope a minimum of 0.2 cm per 0.3 m (1/16 inch per 1 foot) to floor drains. For hangars where aircraft washing (corrosion control) is a function, the floor shall slope a minimum of 0.4 cm per 0.3 m (1/8 inch per 1 foot) to floor drains. Maximum distance from any point on the hangar floor to a floor drain shall be per NFPA code or 22.9 m (75 feet), which ever is more stringent.

8.1.4.2.5. Floor Coating Systems. Do not apply on hangar bay floors where aircraft washing is a primary or secondary function of the space. Provide light color floor coatings with light to medium grit surface for hangar bay space. Follow criteria found in AF ETL 96-5, Hangar Concrete Floor Reflective Coating Criteria. Flooring coatings shall be very durable and shall be completely resistant to discoloration from POL products, rubber, tires and other equipment which will roll across or be parked or stored on the flooring system.

8.1.5. Frost. Any soils which have a portion of their particles smaller than 0.05mm are frost susceptible. Where frost penetration is a problem, the maximum amount of material finer than 0.02 mm diameter shall be less than 3 percent.

8.2. PAVEMENT TYPE:

8.2.1. Rigid pavement shall be provided for:

a. All paved areas on which aircraft are regularly parked, serviced, maintained or preflight checked.

b. Runway ends 304.8 meters (1000 feet), or 60.9 meters (200 feet) on either side of the aircraft arresting systems, whichever is greater).

c. Aircraft Power Check Pads.

d. Aircraft Arm/Disarm Pads.

e. Aircraft Wash Racks.

8.2.1.1. The use of resin modified pavement may be considered as an alternative to rigid pavement for its fuel and abrasion resistant properties where it is determined to be more cost effective.

8.2.1.2. The use of steel fiber reinforced concrete or similar systems is prohibited.

8.2.2. Flexible pavement shall be used for taxiways, the interior portion (between the rigid ends) of runways, paved shoulders, paved overruns, apron shoulders, roadway access to aprons and all other areas not specified above unless the use of rigid pavement can be justified on the basis of cost effectiveness. Taxiways/Taxilanes that are an integral part of an apron layout and tug taxilanes leading to hangars and wash racks shall be rigid pavement.

8.3. RIGID PAVEMENT MATERIALS AND CRITERIA:

8.3.1. Aggregates.

8.3.1.1. Aggregates must conform to the quality requirements of ASTM C33 and percentage of wear testing using ASTM C131 and/or ASTM C535. The grading requirements for coarse aggregates of ASTM C33 do not apply for projects where the placed concrete is more than 3000 cubic meters (3924 cubic yards). For projects where the placed concrete exceeds 3000 cubic meters (3924 cubic yards), aggregate gradation shall comply with the requirements in the USAF Guide Specification for Rigid Concrete Pavements for Airfields (USAF-02515) found in AF ETL 97-5, "Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements."

8.3.1.2. Use maximum size of 1.3 cm (1/2 inch) (100 percent passing 1.9 cm (3/4 inch sieve)) in locations subject to "D" cracking (see AFR 93-5, "Procedures for US Army and US Air Force Airfield Pavement Condition Surveys," for definition).

8.3.2. Air Entrainment. Not less than 4 percent air entrainment.

8.3.3. Flexural strength. 4.5 Mpa (650 psi) at 90 days determined using the procedures of ASTM C78.

8.3.4. Subgrade Compaction. Degree of compaction shall be the following percentages of the maximum density obtained by the test procedure in ASTM D1557, "Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort."

	Cohesive soils	Non-cohesive soils
Fill	90% except 95%- -top 22.9 cm (9 inches)	95%
Cut	95% --top 15.2 cm (6 inches)	100%--top 15.2 cm (6 inches)
		95%--Next 45.7 cm (18 inches)

Note: Stones or rock fragments larger than 10.2 cm (4 inches) shall not be allowed in the top 15.2 cm (6 inches) of the subgrade.

8.3.5. Joints. All joints in rigid pavements within hangars shall be preformed, or formed with the use of inserted strips. Expansion joints of 1.9 cm to 3.2 cm (3/4 inch to 1 1/4 inches) shall be provided between concrete pavements and other fixed airfield structures. All other joint recesses for apron surfaces shall be saw cut. Load transfer across expansion joints shall be provided by dowels or thickened edges. Load transfer across construction joints shall be provided by dowels. The use of key-way joints for joint load transfer is not permitted.). For airfield pavements, use a maximum of 6.2 meter by 6.2 meter (20 feet by 20 feet) concrete panels.

8.3.6. Joint Sealing. Preformed elastomeric seals are required for all new rigid exterior pavements. All poured sealants used within hangar areas that are not to receive floor coating shall be silicone conforming to AF ETL 94-9 "Silicone Joint Sealants for Pavements". Sealants used in hangar areas that are to receive floor coatings shall be compatible with the floor coating system to be provided.

8.4. FLEXIBLE PAVEMENT MATERIALS AND CRITERIA:

8.4.1. Minimum Marshall Stability: 816.5 Kg (1800 lbs).

8.4.2. Coarse Aggregate. Crushed aggregate shall show no more than 40 percent wear, when tested in accordance with ASTM C131, and sodium sulfate loss not more than 90 percent, and magnesium soundness loss not more than 12 percent after 5 cycles (ASTM C88). At least 75 percent, by weight, of pieces must have two or more fractured faces.

8.4.3. Density. 98 percent of laboratory density. Sliding scale pay factors are recommended, as indicated in FAA Guide Specification Item P-401, Plant Mix Bituminous Pavements.

8.4.4. Overlay Thickness. Minimum nominal thickness shall be 6.4 cm (2 1/2 inches).

8.4.5. Sub-grade Compaction. Use the revised table from AFM 88-6, Chapter 2.

SECTION 9 VEHICULAR PAVEMENT AND PARKING

9.1. GENERAL: Pavement design criteria given in this policy shall be supplemented and modified by local and state highway department practices, where investigation has shown that they are adequate and economical, or are required by local conditions. The design life of the pavements shall be for a minimum life of 20 years.

9.2. CRITERIA:

9.2.1. All pavements for roads, streets and parking areas and storage areas shall be designed for the loadings and frequencies expected. AFM 88-7, Chapter 1, "Pavement Design for Roads, Streets, Walks, and Open Storage Areas," is a suggested source for mixed traffic design using a design index of 3, 4, 5 or 6, as required. Computer aided design programs which comply with these standards are available for downloading at the PCASE (Pavement-Transportation Computer Assisted Structural Engineering) web site at www.pcase.com. When actual data is not available, the following criteria shall be used:

AREA	ADT	LOAD
Streets	< 1000	90% Cars and Pickups 10% 10,160 kg (22,400 lb.) Single Axle Trucks
Parking Lots	<1000	95% Cars and Pickups 5% 8,165 kg (18,000 lb.) Single Axle Trucks

9.2.1.1. The provided minimum thickness of flexible pavement shall be 5.1 cm Surface + 10.2 cm Base (2" Surface + 4" Base) with appropriately engineered compacted sub-grade materials. The minimum thickness of rigid pavement shall be 15.2 cm (6 inch) Surface.

9.2.2. Flexible pavement shall include dense graded, sound, angular crushed stone, crushed gravel or crushed slag, and fine aggregate. Marshall Stability shall not be less than 340 kg (750 lbs.).

9.2.3. Rigid pavement shall be air entrained and shall be designed with a slump between 2.5 cm and 5.1 cm (one inch and two inches). Aggregate shall meet the requirements of ASTM-33.

9.2.4. Frost damage and freeze/thaw cycles shall be considered in all pavement design.

9.2.5. Concrete edge protection. Provide hot dipped galvanized steel edge cast integrally into the slab for all horizontal edges or corners such as loading docks, vehicle entrances into facilities and other similar areas. Also provide similar protection for vertical cast concrete surfaces to the appropriate height.

9.3. SELECTION OF PAVEMENT TYPE:

9.3.1. Provide rigid pavement in fueling, refueler parking and all service areas where petroleum and/or detergent products are used and/or may drip or spill onto the pavements, and wherever it's use results in a lower life-cycle construction cost than other paving alternatives. Also provide rigid paving in all areas subject to unique traffic or loads which would otherwise result in asphalt damage, rutting or shoving.

9.3.2. The use of resin modified pavement may be considered as an alternative to rigid pavement for its fuel and abrasion resistant properties where it is determined to be more cost effective.

9.3.3. Where rigid pavement is not required, use flexible pavement for economy of construction and for staged (or phased) construction.

9.3.4. All flexible pavements shall be placed over sound compacted sub-base and shall be constructed in no less than two pavement lifts. Minimum thickness base course shall be applied at the appropriate time during construction. Minimum 5.1 cm (2 inch) thick top course pavements shall be required to be placed as late in the overall construction process as possible so that the finish pavements are not subject to construction activity and damage potential.

9.3.5. Provision of concrete curb and gutter is recommended for all roads and parking lots. Style of curb and gutter shall be in accordance with the base standard. Style shall also accommodate local environment such as roll over style curbing where snow removal is a usual requirement.

9.3.6. Use of crushed aggregate in areas not requiring daily use such as overflow vehicle parking areas, roads to remote facilities, and temporary and seasonal equipment storage areas is recommended, provided that this does not pose a foreign object damage (FOD) potential to the airfield.

9.4. PRIVATELY OWNED VEHICLES (POV's): Provide POV parking spaces for a minimum of 75 percent of the authorized UTA strength. Refer to the project book's facility description (usually Tab A) for the building's occupancy on a UTA. Provide a minimum of one visitor parking space in each facility parking lot. Provide two visitor spaces at Headquarters and at Squadron Operations facilities. Handicapped spaces shall be provided for all facilities requiring handicap access. See ANG ETL 98-2 Compliance with Handicapped Accessibility Standards for handicap requirements. Visitor and handicap spaces are not considered part of the 75 percent UTA parking allocation.

9.5. Parking spaces. Parking lot designs shall use the preferred 90 degree pull-in standard layout, in all possible instances. POV parking space width shall be a minimum of 2.7 meters (9 feet) wide by 5.5 meters (18 feet) deep. Drive lanes shall be of appropriate width for backing out of parking stalls and for two-way traffic through the parking area. In areas where parking spaces abut sidewalks, provide wider sidewalks to accommodate POV overhang. Also carefully consider curb height when designing parking spaces to avoid POV and curb top contact.

SECTION 10 MECHANICAL - HEATING, VENTILATING AND AIR CONDITIONING AND PLUMBING

10.1. GENERAL:

10.1.1. Governing Philosophy. Mechanical systems solutions shall provide for consistent and uniform facility use and operation. HVAC systems shall provide uniform and consistent interior space temperature, while using equipment that is energy efficient and easily maintained. Plumbing systems shall provide user comfort and convenience and shall be constructed of materials that provide for quiet operation, long life and low maintenance. All systems design shall conform to given direction and providing a unified solution for the type of facility to be constructed. Selection of systems, equipment and materials shall continue existing base standards or shall conform to the base's mechanical master plan. All mechanical systems shall be built to quality commercial/industrial standards and shall be provided, complete and usable. Standards for construction workmanship shall be of the highest quality. Mechanical systems design shall ensure the proper level of building environmental conditioning, shall be maintainable and shall be the system with the least life cycle cost (LCC) having met the above requirements. The LCC analysis shall be performed in accordance with Section 3 of this Tab, ECONOMIC ANALYSIS.

10.1.2. Energy Consumption. Select, design and specify heating, air conditioning, evaporative cooling, dehumidification, mechanical ventilation and refrigeration in accordance with the requirements in Section 11 of this Tab, ENERGY CONSERVATION CRITERIA.

10.1.3. Weather Data. Design shall use the data contained in AFH 32-1163 Engineering Weather data. The Data source used is AFH 32-1163, Engineering Weather Data which can be found at http://afpubs.hq.af.mil/ electronic publications, US Air Force, Series 32, chronologically listed as suffix number 32-1163.

10.2. DRAWINGS: Mechanical Drawings shall include but not be limited to:

a. Title on each drawing with correct scale and a north arrow.
b. Each set shall have a mechanical legend indicating:
    1. New –vs.- existing to remain –vs.- demolition.
    2. All HVAC, piping and plumbing symbols, abbreviations and nomenclature.
    3. System referencing and cross-referencing.
c. Provide equipment schedules for all equipment provided. Schedules shall include identification tag, critical design size, capacity information, salient characteristics, required options, efficiency and other pertinent data.
d. Mechanical equipment, systems and materials construction details.
e. Blown-up scale floor plans and elevations/sections of each mechanical room including:

1. Location of equipment (equipment shall be to scale).
2. Routing of all ductwork and piping.
3. Safe clearance areas.
4. Maintenance clearances and maintenance access locations.

f. Each major piece of mechanical equipment shall be shown on a separate supporting detail.

g. Detail designation reference to location on mechanical drawing and cross references to other details or plans.

h. Isometric details showing details not otherwise obvious such as:
1. Piping network diagrams.
2. Equipment to pipe connection diagrams.
3. Plumbing; hot & cold water lines, gas lines, drain, waste & vent lines and compressed air lines.

10.3. AIR CONDITIONING:

10.3.1. Limitations. Air conditioning, evaporative cooling, dehumidification and mechanical ventilation systems are authorized for those buildings and facilities where it is common practice to do so in the local area. All equipment selections shall be based on occupant comfort, maintainability and a LCC analysis.

10.3.2. Replacement/New Systems. Provide air conditioning at the time of construction for new facilities. Replacement of existing equipment and systems with differing equipment and systems is permitted provided a detailed LCC analysis shows the different configuration is more maintainable and economical.

10.3.3. Areas authorized air conditioning.

10.3.3.1. Administrative Facilities. Air conditioning is authorized for comfort cooling of all personnel administrative and office type spaces. Comfort cooling shall fully meet, but not exceed the design conditions.

10.3.3.2. Communications rooms, Vaults, Computer rooms. Air conditioning is authorized for all communications dedicated areas and computer systems areas. Provide dedicated systems for these areas to meet special temperature and humidity control requirements as well as 24-hour daily operations. System operational temperature requirements and/or comfort cooling shall not exceed the design conditions.

10.3.3.3. Command Post, Base Operations, 24 hour manned duty areas and other specific areas within facilities that require operations on a continuous basis, regardless of the use of the rest of the facility, shall generally be provided with dedicated air conditioning systems.

10.3.3.4. Industrial Facilities. Industrial facilities are authorized air conditioning except for within the following areas. Comfort design conditions shall not be exceeded, except for facilities where equipment operation requires other conditions. Adequate ventilation systems in lieu of air conditioning systems shall be incorporated.

10.3.4. Areas not authorized air conditioning regardless of weather conditions.

a. Motor vehicle storage garages.
b. ASE and Vehicle Maintenance bays.
c. Boiler plants and Mechanical equipment rooms.
d. Maintenance areas / shops not requiring temperature and humidity control by T.O.
e. Building mechanical, boiler, air handler and electrical rooms (except communications rooms).
f. Special areas requiring high ventilation rates.
g. Warehouses and Storage facilities.
h. Aircraft maintenance shops. Certain maintenance shops including the avionics shops, bladder repair, composite repair and other specific shops requiring temperature and humidity control per the applicable Technical Order shall be provided proper air conditioning systems.
i. Aircraft Hangar Bays (Maintenance, Phase dock, Fuel cell, Corrosion control, etc.).

10.3.5. Special areas authorized indirect air conditioning. The following areas shall be provided conditioned air through indirect means.

a. Rest rooms, Locker rooms and Showers. Draw conditioned air from the administrative space air conditioned areas to provide cooling for restroom, locker and shower areas. If not possible, then dedicated air conditioning may be provided.

b. Dining facility kitchens. Draw conditioned air from the dining areas to provide cooling for kitchen working areas. Provide outside air directly to exhaust hoods for make-up air. If not possible, then dedicated air conditioning may be provided. Some storage areas within the dining kitchen area my require dedicated air conditioning.

10.3.6. Heat gain calculations for Air Conditioning or Ventilation design basis shall be in accordance with the current edition of the ASHRAE Handbook of Fundamentals.

10.3.7. Facility air conditioning maximum inside design temperature for personnel comfort shall be as follows: The design relative humidity shall be 50%.

Facility Air Conditioning Design Temperature	
Administrative areas and similar office style work spaces, rest rooms, locker rooms, dining areas, exercise rooms, living spaces, classrooms and other areas authorized air conditioning.	60.2° C (78° F)

10.3.8. The outside design temperatures and other important weather data for air-conditioning systems shall be as found in AFH 32-1163. This publication can be found at http://afpubs.hq.af.mil/ electronic publications, US Air Force, Series 32, chronologically listed as suffix number 32-1163. The outside design temperatures and other data shall be selected from the 2% occurrence design values as listed for the entire period of record. In limited circumstance, locations which are subject to extreme weather (desert and arctic regions), the use of the 1% occurrence design values shall be considered. Use of the data as outlined above is for standard non-critical facilities and systems.

10.4. REFRIGERANTS:

10.4.1. The acquisition of facility air conditioning and refrigeration systems using Class 1 Ozone Depleting Chemicals (such as CFC-11 and CFC-12) is prohibited. See ANG ETL 93-3, "Chlorofluorocarbon (CFC) Limitation in Heating, Ventilating and Air Conditioning (HVAC) Systems."

10.4.2. ANG projects shall recover all refrigerants from any existing A/C or refrigeration units that will be removed or salvaged. Recovered refrigerants must be bottled in pressure containers suitable for shipping per DOT requirement and remain property of the Government. Salvage or disposal by contractor is not permitted.

10.5. HEATING:

10.5.1. Heating systems are authorized for all facilities where it is common practice to provide such systems. The building heating systems shall be as simple as possible consistent with requirements for occupant comfort, safety, economy and performance to suit the particular application. Systems shall be properly sized to provide adequate heating levels for design conditions with appropriate safety factors included. If hot water or steam boilers are used, multiple staged high-efficiency boilers using factory manifolds and control systems shall be considered.

10.5.2. The outside design temperatures and other important weather data for heating systems shall be as found in AFH 32-1163. This publication can be found at http://afpubs.hq.af.mil/, electronic publications, US Air Force, Series 32, chronologically listed as suffix number 32-1163. The outside design temperatures and other data shall be selected from the 2% occurrence design values as listed for the entire period of record. In limited circumstance, locations which are subject to extreme weather (desert and arctic regions), use of the 1% occurrence design values shall be considered.

10.5.3. Facility inside design temperature minimums shall generally be as follows:

Facility Design Temperature Minimums	
Administrative areas and similar office style work spaces, rest rooms, locker rooms, dining areas, exercise rooms, living spaces and classrooms.	52° C (70° F)
Hangar shops and active maintenance areas.	47° C (65° F)
Hangar bays, all active storage and warehouse areas.	42° C (60° F)
Areas requiring freeze protection only.	37° C (55° F)

Note: Control system set points may vary from the above and shall be used in determining the energy budget.

10.5.4. In all facilities authorized air conditioning, a combination heating and cooling system shall be provided, except where separate systems are justified for maintainability, operations requirements or on an LCC basis.

10.5.5. For all heating systems, a central facility system is preferred. Where natural gas is available, provision of gas fired hot water boilers is the preferred system.

10.5.6. Infrared heaters shall be considered for shop, warehouse, high bay industrial facilities and hangar spaces, where a fuel supply exists to support them. Otherwise, hot water unit heaters shall generally be used in shop, warehouse, high bay industrial facilities and hangar bays.

10.5.7. Direct fired heaters are prohibited in areas subject to hazardous concentrations of flammable vapors or dust.

10.5.8. Aircraft Hangars. Floor type air handling units shall not be provided for hangars unless the building geometry dictates and a waiver is obtained from ANG/CE. Overhead or side wall mounted hot water unit heaters shall be used with two position control valves and fan on-off control. Heaters may also be NFPA, UL or AGA approved gas or oil-fired, radiant tube heating systems (Infrared heaters) when installed in accordance with NFPA 409 and are shown to be life cycle cost effective.

10.5.8.1. Hangar bay heaters shall be provided with automatic cutoff controls when doors are opened. An allowance of 4 hours shall be made for hangar and aircraft warm-up after the entrance of the largest aircraft to be used, unless infrared heating is provided, in which case the designer shall make appropriate adjustments.

10.6. VENTILATION:

10.6.1. Minimum outdoor or supply rates for occupants in heated or air conditioned spaces shall be in accordance with ASHRAE Standard 62-89 (R) or latest edition, "Ventilation for Acceptable Indoor Air Quality."

10.6.2. Paint booth ventilation requirements shall be in accordance with the design guidance in the reference INDUSTRIAL VENTIALATION, by ACGIH, latest edition for sizing airflow and capacities.

10.6.3. Provide general ventilation for all areas that are not specifically air conditioned with mechanical ventilation for space temperature control. Ventilation systems shall conform to the following requirements:

a. Fans shall generally exhaust through the wall. (avoid roof penetrations at all opportunity)
b. Ventilation shall have architecturally coordinated style and color wall (or roof if necessary) louvers with stainless steel bird and insect screens.
c. Ventilation shall have powered back draft dampers or gravity dampers.
d. Ventilation shall be controlled with DDC controls that have EMCS system interface.
e. Ventilation shall use direct drive or belt driven fans that are statically and dynamically balanced.
f. Ventilation equipment shall be supported from the facility structural steel system or wall mounted and shall have vibration isolation.
g. Provide full equipment and systems identification systems.

10.6.3.1. In some instances, ventilation system design will require that the system is ducted and the ventilation fan be of the modular air handling unit style. Provide these systems in conformance with the requirements of air handling and air distribution as listed herein.

10.6.4. Ventilation systems for bathrooms, shower rooms and locker rooms shall be sized per applicable ASHRAE standard. Ventilation systems for bathrooms, shower rooms and locker rooms also provide for space air conditioning as they draw conditioned air into the space. Design shall provide a minimum of 0.66 cubic meters per minute per square meter of floor area (2 CFM/SF) for these spaces.

10.6.5. Ventilation systems for exercise spaces shall be sized per applicable ASHRAE standard.

10.7. EXHAUST: All designs shall comply with AFOSH 161-2, "Industrial Ventilation."

10.7.1. Refueler vehicle maintenance bays shall be provided with a ventilation rate 14.2 cubic meters per minute (500 CFM (minimum)) at the trench drain and 0.43 cubic meters per minute per square meter (1.5 CFM/SF) of total bay area as a purge/emergency rate. Purge/emergency exhaust shall be enabled by manual control and by liquid/vapor sensors located in the trench drain. Purge/emergency exhaust activation shall be interconnected with EMCS system and shall activate a facility audio/visual alarm as well as send alarm to the base EMCS central control. Ventilation systems shall be controlled such that they are operational only when a vehicle is present in the bay.

10.7.2. Aircraft Fuel Systems Maintenance/Corrosion Control Hangar facilities shall be provided with three (3) air changes per hour for general ventilation.

10.7.3. Aircraft Maintenance Hangar facilities shall be provided with a minimum of one (1) air change per hour for general ventilation.

10.7.4. Specialized Exhaust Systems. The following areas shall be provided with specialized exhaust systems:

10.7.4.1. Equipment exhaust system for carbon monoxide:

Areas required to have equipment exhaust systems for carbon monoxide
Aircraft Support Equipment Shop (Repair Bays)
Base Engineer Maintenance Facility (Power Production Shop)
Fire Station (Apparatus Bay)
Vehicle Maintenance Bays
Refueler Vehicle Maintenance Bay
Any area containing an internal combustion driven engine.

10.7.4.2. Exhaust System interlocked with battery charger:

Areas required to have exhaust systems interlocked with battery charger
Aircraft General Purpose Shop (Battery Shop)
Aircraft Support Shop (Battery Shop)
Vehicle Maintenance Facility (Battery Shop)

10.7.4.3. Exhaust system activated prior to entry:

Areas required to have exhaust systems activated prior to space entry
Hydrazine facility
POL pump house

10.7.4.4. Exhaust systems for trench drains. Provide a vapor detector located in the air stream and interlocked with the floor level exhaust system. Provide additional liquid sensor in trench drain. Use continuous sampling with the capacity based on total trench capacity 14.2 cubic meters per minute (500 CFM minimum). Single point sampling is acceptable. Trench drains that shall have exhaust systems are as follows:

Trench Drains requiring exhaust systems
Aircraft Fuel System Maintenance Bay
Aircraft Corrosion Control Bay (only if used as a backup fuel cell)
Refueler Vehicle Maintenance Bay

10.7.4.5. Exhaust systems with conventional floor level pick-up. Provide a purge/emergency exhaust system with manual control. The volume shall be based on the floor area times 0.6 meters (2 feet). Provide a minimum of twenty air changes per hour based on this volume. Provide this type of exhaust system for the following areas:

Conventional floor level exhaust systems
Hydrazine Storage and Servicing Rooms
Drop Tank Maintenance Shop
Fuel Bladder Maintenance Shop
Blue Foam Storage Room

10.7.4.6. Exhaust systems with special floor level pick-up. Provide a purge/emergency exhaust system with automatic/manual control. The automatic mode shall be interlocked with a vapor detection system. The volume shall be based on the floor area times 0.6 meters (2 feet). Provide 20 air changes per hour based on this volume. In aircraft bays, provide a minimum of three pickup points. Provide this type of exhaust system for the following areas:

Special systems floor level exhaust systems
Aircraft Fuel System Maintenance Bay
Aircraft Corrosion Control Bay (only if used as a backup fuel cell)
Refueler Vehicle Maintenance Bay
POL pump house

10.7.4.7. Exhaust systems with localized pick-up for aircraft fuel cell cavities, solvent tanks, workbenches, lab units, equipment, etc. Provide this type of exhaust system for the following areas:

Local area pick-up exhaust systems
Aircraft Fuel System Maintenance Bay
Aircraft Corrosion Control Bay (only if used as a backup fuel cell)
Composite Squadron Operations (Survival Equipment shop)
Vehicle Maintenance Facility
Weapons Release Shop
Welding Shop
NDI Shop
Base Photo Lab
POL Lab
Munitions Maintenance and Storage Facility
Hydrazine Storage Room
Cleaning rooms:
Aircraft Engine Inspection and Maintenance Shops
Aircraft Corrosion Control Facility
Aircraft Support Equipment Shop and Storage Facility
Security Police Operations

10.7.4.8. Exhaust systems with dust collector interlocked to individual pieces of equipment. Provide this type of exhaust system for the following areas:

Exhaust systems with dust collector
Composite repair shop (Maintenance Hangar)
Carpenter shop (BCE Facility))
Packing and crating area (Base Supply Facility)

10.7.4.9. Paint bay exhaust systems shall be interlocked with the following in order to function:

Paint bay area exhaust systems with interlock
Breathing air systems
Makeup air systems
Paint spray equipment via the air compressor

10.8. ROOF PENETRATIONS: Air conditioners, cooling towers, air-cooled condensing units and ductwork shall not be located on roofs. Waivers to this policy must be obtained from ANG/CE and require special design justification and written request from the BCE. Exhaust and ventilation system shall be through the wall systems when possible to limit roof penetrations. In the event that roof penetrations are necessary for ventilation, exhaust or flues, all penetrations shall conform to most recent edition of NRCA roofing details. All roof-mounted items shall be finished in colors that match the roofing color and/or shall be architecturally screened.

10.9. UTILITIES:

10.9.1. Gas, water, and electricity shall be metered (or sub-metered) at each service entrance of each facility. Major non-facility points of use on ANG sites shall also be metered at each service entrance. Examples of non-facility major points of use are site lighting, parking lot lighting, apron lighting, aircraft wash racks, etc. Electricity must metered for both demand and consumption, kWh and kW.

10.9.2. Gas, water and electricity shall be master metered at utility service points to the base and meters shall be monitored by the EMCS. Electricity must metered for both demand and consumption, kWh and kW.

10.9.3. District steam, HTHW or medium temperature hot water, or district chilled water shall have BTU monitors.

10.9.4. Meters shall be designed for installation per local standards, (i.e. gas meter settings per local gas company standards, etc.). Metering systems should be base wide standardized for maintenance and compatibility.

10.9.5. Water meters on fire water lines are not usually required unless the base is billed for quantities used.

10.9.6. The base EMCS system shall monitor utility metering at each facility and non-facility major points of use. DDC points must be installed.

10.9.7. Facility and non-facility major point of use meter outputs shall be capable of being read at the facility or point of use as well as be capable of being obtained through the base EMCS system monitoring.

10.10. ACCESS TO MECHANICAL EQUIPMENT:

10.10.1. Provide through roof man way or permanent exterior cage style ladder access to the few pieces of mechanical equipment that must be mounted on the roof. Roof access shall be designed to prevent unauthorized and uncontrolled access.

10.10.2. For flat roof areas (regardless of roofing type), provide full 2.5 cm (1 inch) thick neoprene walk pads from the roof access point to and completely around each piece of equipment.

10.10.3. Provide access stairs, cage style ladders, catwalks and/or work platforms at all equipment that is mounted at more than seven feet above finish floor, including hi-bay areas of aircraft hangars. Access shall be designed to prevent unauthorized and uncontrolled access. Interior access construction shall be hot dipped galvanized steel. Exterior access construction shall be finished in architecturally compatible base color.

10.10.4. Insure that design of mechanical equipment areas are of sufficient size and accessibility to provide adequate clearance around each item of equipment, including:

a. Room to pull heating and cooling coils out of the sides of units.
b. Room to easily change air filters.
c. Room to pull tube bundles.
d. Room to fully open all access panels and doors.
e. Adequate space between equipment for servicing and removal of motors, compressors, etc.
f. Safe clearance around all electrical panels.

10.11. MECHANICAL ROOM DESIGN:

10.11.1. Provide mechanical room designs that are large enough to provide adequate clearances around mechanical equipment including:

a. Room to pull heating and cooling coils out the side of units.
b. Room to easily change air filters.
c. Room to pull tube bundles.
d. Room to fully open access doors.
e. Adequate space between large equipment pieces.
f. Room to service and remove items such as motors, compressors, etc.
f. Room to access lubrication points and other maintenance features.
f. Safe clearance around electrical panels.
g. Avoid locating equipment behind access panels or in adjacent spaces.

10.11.2. Centrally locate all mechanical equipment in mechanical room to fullest extent possible. This shall include, water heaters, central air handling units, fans and blowers, boilers, pumps, heat exchangers, chillers, compression and expansion tanks, compressors, refrigerated dryers, HVAC control panels and other types of mechanical equipment.

10.11.3. Use of rooftop AHU's and ceiling located AHU's are generally prohibited. Application of these systems requires clear justification to be provided by the BCE for ANG/CE approval. If approved, required maintenance access systems shall be provided.

10.11.4. Do not design or allow mechanical rooms to be treated as joint space (i.e. storage). Provide mechanical rooms with double exterior-swing, 0.9 meter (3 foot) metal doors only. No interior access shall be provided to mechanical rooms.

10.11.5. Gas, water, central steam and/or high temperature hot water systems shall have planned service entrances into the mechanical rooms. Piping entrance through the foundation directly into a concrete vault or pit in the mechanical room is preferred, thus avoiding having a utility system under the facility floor slab. Water meters shall be located in the mechanical room.

10.11.6. Do not allow any water piping system to pass over or be located within three feet of any electrical panel. Space clearance zones required by the NEC above and aside of electrical panel shall be maintained.

10.11.7. Provide LAN, data and telephone service in mechanical rooms. Provide GFIC 110 v convenience outlets in mechanical rooms and mechanical courtyards. Provide lighting and convenience outlets at other mechanical equipment items if not located in the mechanical room.

10.11.8. Mechanical room lighting shall use a larger number of small lighting fixtures to avoid shadow and dark areas. Lighting layout shall be fully coordinated with equipment and duct layout.

10.11.9. Provide floor drains in mechanical rooms and hose bibs at mechanical rooms and at mechanical courtyards. For mechanical rooms with oil fired equipment, provide secondary containment or other approved method of ensuring that any oil spill will not enter the floor drain.

10.11.10. All HVAC equipment that is grade mounted shall be mounted on chamfer edge concrete house pads, 10.2 cm (4 inch) thick and 15.2 cm (6 inch) dimension larger than the unit, minimum.

10.11.11. Provide sleeves at all penetrations. Sleeve shall seal at all wall and floor penetrations. Floor penetration sleeving shall extend a minimum of 10.2 cm (4") inches beyond the floor and shall be completely sealed to the floor material.

10.11.12. Ensure that mechanical room design size is large enough to accommodate equipment that is submitted by contractor.

10.11.13. Mark clear zone for coil and tube pull on the plans and specify to have clear zone painted on mechanical room floor.

10.11.14. Clearly show in the design reserved clear wall space for the location of the posted operations instructions.

10.11.15. Provide a wall mounted mesh style lockable storage cabinet for locating copies of the O&M manuals in the mechanical room. Locks for each facility cabinet shall be keyed alike.

10.11.16. Mechanical room construction shall be of block or masonry brick construction that extends to the roof deck. Mechanical room walls, ceilings and floors shall be acoustically improved to prevent noise transmission into the occupied spaces. Mechanical room walls shall be block filled and painted with durable light color semi-gloss paint. Mechanical room ceilings shall either be painted exposed structural steel and painted steel roof deck, or painted drywall construction. Exposed interior insulation is not permitted. Mechanical room floors shall be of sealed concrete.

10.11.17. Use of mechanical room vertical space is encouraged. Placement of pumps on vertical pump racks, mounting of expansion tanks and other devices to walls and structural supports is encouraged. AHU's and fans may be located above finish floor, but in all cases provide full equipment access.

10.12. MECHANICAL COURTYARD DESIGN:

10.12.1. Required exterior mechanical equipment such as cooling towers, condensing units, package chillers, generators, etc. shall be located in screened mechanical courtyards adjacent to the mechanical room. The courtyard wall system shall be architecturally compatible with the facility and use the same construction materials as the facility.

10.12.2. The mechanical courtyard shall have sight proof architectural single and double swing gates with concrete access drive or wide sidewalk from nearest road. All courtyard located equipment shall have full clearance all around the equipment for required airflow and maintenance access. Provide architectural sight proof louvers in the courtyard screen wall where necessary to facilitate airflow requirements for air-cooled equipment. The screened courtyard shall have a fully jointed concrete finished floor and shall positively drain. All equipment mounted in the courtyard shall be mounted on chamfer edge concrete house pads, sized slightly larger than the specific item of equipment provided. The screened courtyard wall height shall be required to be higher than the specific piece of manufacturer equipment provided. The courtyard shall have exterior GFIC convenience outlets, freeze proof hose bib and adequate exterior lighting provided by HPS wall packs or similar lighting.

10.12.2.1. Emergency generators or temporary emergency generator location shall also be within the (or a) screened courtyard. Generator location shall be accessible by forklift.

10.12.3. Mechanical equipment and components of all systems located in exterior spaces shall be finished in colors that are coordinated with the base color palate. Specify factory finishes where available.

10.13. VIBRATION ISOLATION:

10.13.1. Require full vibration isolation systems at all air handling units, fan coil units, return air fans, exhaust fans, compressors, base mounted pumps, in line suspended pumps, large volume piping (5.1 cm (2 inch) and greater diameter) and for other similar equipment and systems. Isolation systems shall completely isolate equipment from the facility and control all noise and vibration transmissions.

10.14. AIR HANDLING SYSTEM:

10.14.1. All HVAC ductwork shall be galvanized steel with G90 coating. The design and construction of air handling systems shall meet the requirements of Uniform Mechanical Code Chapter 6 and SMACNA Construction Standards which ever is more conservative. Use of fiberglass or fiberboard constructed air ducts is prohibited.

10.14.2. Design of all air handling systems shall include fully ducted supply, return and exhaust air. No duct system shall be routed underground. Design calculations shall include systems effect calculations which follow AMCA criteria.

10.14.3. All duct balancing devices shall be heavy duty, opposed blade type devices. Actuator shall extend through the insulation system with extension standoff and shall not degrade the vapor barrier system. Actuator shall be lockable with setting indicator.

10.14.4. Provide duct smoke detectors (supply and return) for each system that is over 2000 CFM per UMC Section 608.

10.14.5. All product-conveying duct system shall be designed and installed in accordance with the requirement of UMC Section 609.

10.14.6. Provide external FSK foil faced wrap insulation or rigid duct insulation per UMC Section 604. Generally, do not provide internal insulation/sound attenuation systems.

10.14.7. Flexible duct shall be factory pre-insulated meeting NFPA 90A. All flex duct runs shall be limited to 1.5 meters (5'foot) maximum length. Flexible duct shall be banded and clamped onto a minimum 10.2 cm (4 inch) length galvanized steel round clamping collar. Banding shall be nylon straps, fastened under insulation and over the inner liner with a second band securing the insulation and jacket. Seal ends of flex duct with foil duct tape over insulation and jacket. Support flexible duct with minimum 2.5 cm (1 inch) wide metal strap hangar.

10.14.8. Support all duct systems from facility structural members and not from the roof deck system. Use trapezes, channel iron, angle iron, all thread hangars and beam clamps. Provide vibration isolation systems on duct supports as appropriate and required to prevent the transmission of noise or vibration.

10.14.9. Provide curved foil turning vanes at all ductwork changes in direction.

10.14.10. Provide access panels (pre-manufactured type) for access to all fire dampers, VAV reheat coils and other items requiring access for service/maintenance.

10.14.11. All duct systems in exposed/occupied spaces shall have design consideration for aesthetic impact and shall be painted in architecturally selected colors.

10.14.12. Provide full air distribution system identification at each side of a wall penetration, in the mechanical room, at all changes of direction and at no more than 15.2 meter (50 foot) intervals. In exposed locations, identification shall be preprinted labels. In concealed locations, identification may be professionally stenciled.

10.14.13. Provide spiral wound duct systems for all exposed duct configurations, (shops, high bay locations, etc)

10.14.14. Provide flanged and bolted duct systems for all mechanical rooms and for the duct systems that are largest in cross section.

10.14.15. Underground duct systems are prohibited.

10.15. LOUVERS AND GRILLS:

10.15.1. Exterior intake louvers shall be located opposite from the prevailing wind direction. Locate on leeward side of facilities. Additionally, all intake air louvers shall be located clear of any sources of heat, noise, odor and pollution. Exhaust and intake louvers shall be located as far apart from each other as design allows.

10.15.2. All exterior louvers shall be integrated architecturally into the facilities overall image. Layout and placement shall coordinate with facility architecture. Louvers shall be sight proof, organically coated aluminum or anodized aluminum selected in colors that complete the facility colors. Provision of Mill finish (aluminum) is prohibited. All louvers shall be provided complete with stainless steel insect and bird screen.

10.15.3. Provide oversize exterior louvers in appropriate locations to facilitate future removal/replacement of equipment such as air handling units, etc.

10.15.4. Interior supply louvers and grills shall be consistent throughout the facility. Generally provide for 0.6 m by 0.6 m (2 foot by 2 foot) lay-in application. Avoid specification of supply grills that use the honeycomb or egg crate style cover.

10.15.5. Interior return registers and grills shall be selected as appropriate for the system. Select sized that are on the larger side of design requirements to avoid system noise generation. Registers and grills shall be sight proof or the ductwork behind the register or grill shall be painted full flat black.

10.15.6. Fully coordinate layout and installation of all louvers, registers and grills with building lighting, communications, sprinkler systems and other facility features.

10.16. AIR HANDLERS AND FANS:

10.16.1. Select models for quiet operations, durability and maintainability.

10.16.2. Ductwork within the mechanical room and that connected to the AHU or fan unit shall be flanged and bolted type, externally insulated. Provide neoprene vibration isolation flange at connection to units.

10.16.3. AHU shall have supply and return smoke detectors, installed per NFPA and UMC.

10.16.4. AHU and fan units shall be double wall modular design with integral insulation and double hasp access doors.

10.16.5. AHU and fan units shall be capable of installation into and removal from the mechanical space after all walls and ceiling structures are in place.

10.16.6. Modular components shall include supply fan, return fan, hot water and chilled water coil banks, filter section, dampers, etc.

10.16.7. All circulating air systems shall be provided with filter sections.

10.16.8. Filter sections shall be for minimum 5.1 cm (2-inch) thick, pleated media fiberglass disposable filter. Filters shall be installed on the incline, and not as a flat plane. Efficiency shall be specified in the 30 to 40% efficiency range. Filter sizes shall be standard locally available sizes. Filters shall be in place before any AHU fans are operated and shall be maintained throughout the remaining construction cycle.

10.16.9. Provide EMCS control to supply outside air meeting ASHRAE minimum CFM per person when air demand is the lowest.

10.16.10. The AHU unit shall be capable of 100% outside air intake. It shall use a modulating economizer up to 100% outside air and shall be controlled by and with enthalpy sensors.

10.16.11. Provide supply and return fans with variable frequency drivers and internal isolation spring/vibration assembly. Vortex dampers are not the preferred method of variable air volume control.

10.16.12. Mount AHU units or fan units on chamfer edge concrete house pads or appropriate structural support system if located above grade. AHU and fan unit mounting shall include full vibration isolation spring assembly (additional to fan spring housing).

10.16.13. AHU and fan units shall be located with clearance all around unit for servicing, lubrication, filter changes and other maintenance.

10.16.14. AHU and fan units located above finish floor, in overhead or mezzanine locations shall have finished steel catwalk/service platforms and stair access to the platform.

10.16.15. Piping to the AHU coils shall have unions provided at the coil so that the coil may be removed readily without removing any adjoining piping.

10.16.16. Piping shall be complete with full port ball shut off valves.

10.16.17. Balancing valves are to be provided at all coils with memory stop, lockable position with scale and taps for flow measurement.

10.16.18. Chilled water and hot water coils shall be made of minimum 1.3 cm (1/2 inch) copper tube. A minimum of 6 rows of chilled water coils shall be provided.

10.16.19. Pressure gages and thermometers shall be located at inlet and outlet sides of all coils.

10.16.20. Spring isolation pipe hangars supported from facility structural members shall be provided. Provide calcium cilicate (hard) insulation with full pipe saddles at all hangars.

10.16.21. Provide full thermal pipe insulation and pipe identification system.

10.16.22. Provide full equipment identification systems. Identification shall be large engraved identification plaques screwed or riveted to the units. Coordinate identification systems to the posted instructions and to the EMCS system graphics.

10.16.23. Provide full DDC control for all equipment and systems and provide monitoring and interface with EMCS systems.

10.17. VARIABLE VOLUME BOXES:

10.17.1. VAV boxes shall be pressure independent type.

10.17.2. Provide reheat coils with full valve accessories including balancing sets with memory stop, lockable position with scale and taps for flow measurement, unions, isolation ball valves and sound attenuators.

10.17.3. Do not place duct balancing damper assemblies upstream of VAV boxes.

10.17.4. Provide DDC control with EMCS interface for each VAV.

10.17.5. All variable volume boxes shall be fully accessible for maintenance and replacement purposes.

10.17.6. VAV with reheat coils shall have duct access panel at coil for cleaning and service.

10.17.7. Support VAV from facility structural members with spring isolators.

10.17.8. Provide full equipment identification systems. Identification shall be large engraved identification plaques screwed or riveted to the units. Coordinate identification systems to the posted instructions and to the EMCS system graphics.

10.18. HYDRONIC SYSTEMS:

10.18.1. Type L copper piping for hot water and chilled water circulation systems for all pipe sizes 7.6 cm (3 inches) and smaller are recommended, unless local water makeup and conditions would present an unusual corrosion problem. All fittings shall be wrought copper. Consider use of type L copper for larger piping sizes based on amount of piping and economics. If practical, then use type L copper for all piping sizes. Provide cathodic isolation for all piping systems of dissimilar metals.

10.18.2. All air vents must be valved.

10.18.3. Use manual air vents only in spaces outside of the mechanical rooms. Provide at all high points in all systems.

10.18.4. Avoid directly buried heating and cooling pipes; use a conduit, concrete trench and grating, or newer, insulating materials especially designed for surrounding underground pipes. Where possible, route pipes above grade within mechanical courtyard or similar area. By the same token, do not route piping above grade in such a manner that would affect the architectural aesthetic of the facility, or that would create a servicing obstruction or a tripping hazard. Do not place piping in such locations that the pipe must be stepped on in order to service or gain access to any items.

10.18.5. Balancing valves or calibrated devices are required at all hydronic terminal units. (Coils, unit heaters, fan/coil units, etc.) and circulating pumps. Balancing devices shall be provided with memory stop, lockable position with scale and taps for flow measurement

10.18.6. Near boiler/chiller piping requirements:

a. Dedicated air separator and air vent with bladder compression tank.

b. Compression tank must be located on the suction side of the pumps.

10.18.7. Make up water line shall be provided and shall be of the manual type. The make up water system shall include a quick fill feature, a reduced pressure valve, relief valve, and a reduced pressure backflow preventer with fill cup and drain line.

10.18.8. Design or construction that passes any water pipe over top of or within 0.9 meters (3 feet) over any electrical panel is prohibited.

10.18.9. Support all piping from structural members. Provide spring isolation pipe hangars supported from facility structure.

10.18.10. Provide calcium silicate (hard) insulation with full pipe saddles at all hangars for all pipe sizes.

10.18.11. Provide full thermal pipe insulation and pipe identification system. Pipe shall be identified at all changes in direction, on either side of any wall or floor penetration and at a minimum distance of 12.2 meters (40 feet) on center. Identification systems shall be color coordinated and indexed back to the posted operations instructions and to the EMCS systems graphics. Identification within occupied spaces and mechanical rooms shall be of professional pre made slip on type. Identification above ceilings and in other concealed spaces may be of professional, color-coordinated stencil.

10.18.12. Valves shall be provided as necessary to fully operate and maintain the system. Valving to isolate portions of the system for maintenance and to limit the extent of maintenance activity shall be provided. Generally, all valves shall be of full port ball valve type or butterfly valves.

10.18.13. Do not mount or run any piping systems up exterior facility walls.

10.18.14. Provide flanged connections and unions at all connections to equipment and coils. Connections and unions shall be so located that piping may be easily removed for equipment and coil removal. Identify all flange and union locations.

10.18.15. Provide hydronic design that includes duplex (back up) pumps for all heating systems.

10.18.16. Provide capability for measurement of full hydronic system flows in all main and sub main circuits. All hydronic systems shall provided with flow control and flow setting devices.

10.18.17. Provide full size line strainers in hydronic systems prior to all equipment and all coils. All strainers shall have blow off ball valve, nipple, cap and chain.

10.19. PUMPS:

10.19.1. Provide factory suction diffuser at inlet of floor set pumps.

10.19.2. Select models for the highest energy efficiency, with a minimum acceptable level of 80% efficiency.

10.19.3. Pump casing shall be factory insulated with removable/reusable insulation for servicing. (Pre-manufactured removable insulation jackets specific to the pump model.)

10.19.4. Pumps mounted at grade shall be mounded on concrete inertia pads isolated from the floor slab with expansion joints. Provide a pad that is a minimum of 10.2 cm (4 inches) higher than the adjacent slab with 2.5 cm (1 inch) chamfered edge.

10.19.5. Pumps shall be stacked in vertical structural steel pump racks to conserve floor space where possible. Isolate pumps from support with spring isolation systems.

10.19.6. Pumps located in outdoor locations shall be specified for outdoor service and shall be provide with weather cover (canopy) regardless.

10.19.7. Spring isolation pipe hangars supported from facility structural members shall be provided for piping serving pumps. Provide calcium cilicate (hard) insulation with full pipe saddles at all hangars.

10.19.8. Provide full equipment identification systems. Identification shall be large engraved identification plaques screwed or riveted to the units. Coordinate identification systems to the posted instructions and to the EMCS system graphics.

10.19.9. Circulating pumps must be aligned, shimmed and set in non-shrink grout, per original manufacturer instructions.

10.19.10. Provide full DDC control and monitoring and interface with EMCS systems. Monitor such items as flow, pump on/off, pressure and temperature data.

10.19.11. Pump piping inlets shall provide:

a. Ball shut-off valves
b. Strainer with ball blow off valve, nipple, cap and chain
c. Pressure Gauge
d. Temperature Gauge
e. Stainless steel banded vibration isolator
f. Suction diffuser
g. Flanged connections for service (or union as suitable)

10.19.12. Pump piping discharge shall provide:

a. Ball shut-off valve
b. Balancing device with setting memory and flow measurement taps
c. Check valve
d. Temperature Gauge
e. Pressure Gauge
f. Stainless steel banded vibration isolator
g. Flanged connections for service (or union as suitable)

10.20. BOILERS:

10.20.1. Boilers shall be gas or oil fired forced draft water tube type. The water tube shall be flexible type.

10.20.2. Boilers shall have minimum efficiency of 85%.

10.20.3. Boiler vent system shall be stainless steel inner liner with stainless or galvanized steel outer jacket (Type B) and shall meet AGA criteria. Roof penetration shall be per NRCA detail. Roof portion of vent shall match roof in color.

10.20.4. The boiler shall bear ASME stamps.

10.20.5. Gas burners and controls shall be modulating type, UL and/or FM approved.

10.20.6. Multiple boilers shall be manifolded together with manufacturer provided manifold kits. Provide minimum two (2) 60% boilers for building heating.

10.20.7. Boilers shall be mounted on 10.2 cm (4-inch) chamfer edge house pads.

10.20.8. Units shall be capable of installation into and removal from the mechanical space after all walls and ceiling structures are in place.

10.20.9. Hot water system piping shall be type L copper. Requirements for all piping shall be as specified in the Hydronics portion of this Section.

10.20.10. Provide pressure and temperature gauges at boiler inlet and outlet.

10.20.11. Provide temperature gauge on exhaust vent.

10.20.12. Provide unions, full port ball valves and all trim as required.

10.20.13. Provide full equipment identification systems. Identification shall be large engraved identification plaques screwed or riveted to the units. Coordinate identification systems to the posted instructions and to the EMCS system graphics.

10.20.14. Provide full DDC boiler controls and interface with the EMCS system.

10.20.15. Provide air separator and compression tank on suction side of the hot water pumps.

10.20.16. Provide chemical treatment systems for the boiler water system to reduce scale formation and corrosion problems.

10.21. CHILLERS:

10.21.1. Chillers shall generally be specified to be air-cooled reciprocating type, with copper coil and shall be dual circuited.

10.21.2. Capacity shall be achieved with fewest compressors possible. Generally, no more than four compressors be specified per chiller.

10.21.3. Chiller location shall be within the screened mechanical courtyard and the chiller shall be mounted on a minimum 10.2 cm (4 inch) chamfer edge house keeping pad.

10.21.4. Provide integrated microprocessor control and refrigeration cycle optimization devices. Additionally, provide electronic expansion valves.

10.21.5. Provide multi step capacity reduction control, hot gas by pass and/or other control methods.

10.21.6. Provide with manufacturer flow switch, flow controls, heavy duty coil guards, single point connection and factory wired controls.

10.21.7. Select in factory finish colors that coordinate with base finish palate or specify field painting as required.

10.21.8. Provide air separator and compression tank on suction side of chilled water pumps.

10.21.9. Provide low ambient capability for system where necessary.

10.21.10. Chiller efficiency shall be specified in the upper 15% efficiency for all similar equipment manufactured.

10.21.11. Chilled water system piping shall be type L copper. Requirements for all piping shall be as specified in the Hydronics portion of this Section.

10.21.12. Provide full equipment identification systems. Identification shall be large engraved identification plaques screwed or riveted to the units. Coordinate identification systems to the posted instructions and to the EMCS system graphics.

10.21.13. Interface all chiller control and refrigerant monitoring with the base EMCS system.

10.22. PLUMBING:

10.22.1. Unless otherwise noted, the following materials are recommended to be used for piping systems:

10.22.1.1. Water supply lines to the facilities.
Ductile iron, factory wrapped.
Copper ASTM B88 type 'K' if less than 5.1 cm (2 inches) in diameter.

10.22.1.2. Base water distribution system. Each system shall have curbside ball shut off and individual back flow prevention device for service to each facility or major point of use.

10.22.1.3. Water supply lines inside facilities.
Above grade, copper ASTM B88 type 'L'
Below grade, copper ASTM B88 type 'K'

10.22.1.4. Facility supply water system. Each fixture and point of use shall have shut off valves. For valving, use brass bodied ball valves. Facility water meter shall be located inside mechanical room and shall be readable at the facility as well as through the EMCS system.

10.22.1.5. Sanitary waste and vent lines at facilities.
Above grade, Cast iron, hubless.
Below grade, Cast iron CISPI 301.

10.22.1.6. Sanitary waste system. Each floor drain shall have a deep trap with trap primer. Primers shall all be fed via copper tubing from a central facility primer manifold system. Primer manifold, timer and controls shall be located in the mechanical room.

10.22.2. Plumbing Fixtures and Equipment:

10.22.2.1. All fixtures shall be commercial grade, or industrial as appropriate.

10.22.2.2. All hose bibs, wall hydrants, spigots and service, slop and mop sink fixtures and swamp cooler supply lines shall have vacuum breakers provided.

10.22.2.3. Faucets shall be cast brass body, generally of polished or brushed chrome finish. Operation shall be manual two lever or single lever mixing valve type with ceramic washer. As an option valves may be electronic (no battery) IR type (Sloan or approved equal). Develop methods to ensure that hot water is provided consistently and without delay to all restroom fixtures.

10.22.2.4. Water closets shall be vitreous china, elongated bowl, siphon jet style, water saving type with white open face toilet lid. Closet shall be wall mount type (Kohler or approved equal). Flush valve shall be lever action style or may be electronic (no battery) IR type with individual shut off valve (Sloan or approved equal). Valve finish shall match faucets.

10.22.2.5. Urinals shall be vitreous china, wall mounted, water saving type (Kohler or approved equal). Flush valve shall be lever action style or may be electronic (no battery) IR type, with individual shut off valve (Sloan or approved equal). Valve finish shall match faucet.

10.22.2.6. Slop sinks shall be enameled cast iron with stainless steel rim guard. Faucets shall be industrial gooseneck style with bucket hook and shall be rough chrome finish with vacuum breaker.

10.22.2.7. Floor Mop sink shall be enameled cast iron with stainless steel rim guard. Faucets shall be rough chrome finish gooseneck style with bucket hook and shall have a vacuum breaker.

10.22.2.8. Service/shop sinks shall be heavy gauge stainless steel construction, deep bowl with minimum 2.5 cm (1-inch) radius eased edges. Provide with back-splash and integral drain board where required. Faucet shall be as indicated for floor mop sink.

10.22.2.9. Facility hose bibs shall be brass fixture or brass service box and shall have vacuum breaker. Locate in each mechanical room, mechanical courtyard, on each facility wall and at other service/use locations.

10.22.2.10. Floor Drains shall be cast iron with deep trap and automatic primer. Do not use round drain style in floor locations to receive tile. All trap primers shall be controlled from a facility central trap primer manifold (locate in mechanical room) with brass valves and timer control.

10.22.3. Valves: All valves shall be brass of the following type:

At curb for each facility	ball valve
Facility main interior shut off	ball valve
All internal facility valves	ball valve

10.22.4. Electric Water Coolers shall be wall hung, with complete stainless steel construction. Cooler shall be ADA approved dual fountain, extended receptor, and front push bar. Locate coolers in recessed hall or room alcove areas.

10.22.5. Emergency Shower/Eyewash shall have tempered water supply with minimum 3.2 cm (1 1/4 inch) water service and shut off valve. Locate stations as required by Technical Orders, AFOSH requirements and at all locations where industrial work using chemicals of any type, use of solvents and use or handling of oils/fuels occur. Supply freeze-proof valves if units are located outdoors. Provide instant-action, stay-open brass ball valve with foot-treadle. Provide audio and visual alarm for all shower/eyewash stations. Interlock alarm with base EMCS system. Provide drainage at locations with emergency shower stations.

10.22.6. Water Heaters shall be gas fired, glass lined, ASME stamped, with electronic intermittent ignition device and with copper tube heat exchanger. Provide ASME temperature and pressure relief valve with direct discharge into that rooms floor drain. Water heaters shall have 10 year warranty. Provide dielectric couplers at connection points. Install heaters on concrete house keeping pads or on floor stands.

10.22.7. Backflow and Cross Connection Requirements:

10.22.7.1. Comply with current local code for installation. Require reduced pressure type on all make-up water supplies to boiler water, chiller water, other processed water equipment and make-up water to any hydronic system that contains chemical treatment additives or anti-freeze (glycol solution). Require the double check valve assembly type on fire water risers that meet NFPA criteria and that are UL/FM approved. Require double check valve assembly types at main water service entrances to each facility. Require vacuum breakers at all mop sinks and at swamp coolers, wall hydrants, hose bibs, and spigots that are connected to the domestic water supply.

10.22.7.2. Include in the specification a requirement that the contractor develop a distinct tabbed section in the O&M manual for full maintenance and servicing procedure for all backflow and cross connection devices installed as part of the project. Each of these items shall be specifically listed in a comprehensive table. Specify provision of blank forms and checklists for maintaining records of maintenance of these items. Include full manufacturer original manuals, parts lists and service requirements. Provide for an initial code compliant certification of the item. Additionally, provide final certification by the contractor at the end of the one year facility warranty. All information shall be provided to the BCE such that it can be incorporated into the BCE backflow prevention equipment maintenance and yearly inspection/certification requirements. Specify provision of appropriate training of base personnel for local jurisdiction required yearly testing and certification.

10.22.7.3. The BCE will use information provided by the designer and the contractor and incorporate this information and training into the required base backflow prevention maintenance and certification program.

10.23. DRAINAGE SYSTEMS:

10.23.1. As a general rule, all environmentally unsafe liquid chemicals shall have secondary containment as minimum control.

10.23.2. The following areas are authorized floor drain systems that are connected to the sanitary sewer via an oil/water separator.

a. Corrosion Control Hangar (Main Hangar Bay Only)
b. Engine Shops (Areas where engines being maintained contain fuel only)
c. Fuel Cell Hangar (Main Hangar Bay and Bladder Maintenance Only)
d. Hush House
e. Dining Hall Kitchen Facilities (connect via grease trap)
f. Maintenance Hangar (Main Hangar Bay Only)
g. Vehicle Maintenance Bays (Vehicle, ASE and Refueler)
h. Hangar Fire protection HE and Pump room

10.23.3. The following areas are authorized floor drains that are connected directly to the sanitary sewer system.

a. Rest room facilities
b. Locker and Shower rooms
c. Laundry rooms
d. Mechanical rooms (provide secondary containment or other approved method to contain fuel products if oil fired equipment is provided)
e. Utility rooms
f. Janitor closets

10.23.4. Vehicle Wash Racks. Vehicle wash racks shall be covered and discharge to the sanitary sewer system via a dedicated oil/water separator. If not covered, the wash rack shall have full provision for a drainage system that allows free storm water drainage with manual capability to divert wash water to the sanitary sewer via a dedicated oil/water separator. Wash rack operation shall not be possible unless the drainage system is directed to the oil/water separator.

10.23.5. Aircraft Wash Racks. All aircraft wash racks shall include provision to divert wash water through a dedicated oil/water separator to the sanitary sewer and yet allow for manual selection of free discharge of storm water to the storm sewer system. Wash rack operation shall not be possible unless the drainage system is directed to the oil/water separator.

10.23.6. Deicing Systems. Deicing systems shall be designed to allow for free flow of storm water to the storm water system. The system shall be capable of manually switching from storm water flow to the deicing containment tanks. If underground tanks are used, then piping and tanks shall have required containment and monitoring systems. If the deicing system is co-located at the wash rack, then provision must be incorporated to ensure that the deicing operation cannot operate unless the correct drain lines are selected for full containment of the deicing fluids.

10.23.7. Vehicle Covered Parking. Covered parking areas shall not have floor drains. Floors shall be sloped to positively drain to the exterior.

10.23.8. POL Operations. The POL fuels lab shall not be provided a floor drain.

10.23.9. POL areas including bulk storage, refueler maintenance, refueler parking, fill and off load stands and GOV fuel areas shall all be provided with containment systems. Generally, for exterior containment, depressed or curbed concrete containment areas should be provided with drainage that connects to both the storm water system and to the sanitary system, via an oil/water separator. The system shall have manually operated valves that are normally closed. After rainfall or snowfall, personnel will visually inspect and test contained water for contamination. If no contamination is found, selection of the valve for drainage to the storm water system shall be possible. In the event that contamination is found, or in the event of a spill, as much product as possible shall be directly captured and cleaned up in accordance with federal, state and local environmental requirements. The containment area shall then be selected for diversion of remaining water through the oil/water separator to the sanitary system. For containment areas servicing vehicles, primary spill containment shall not be directly underneath or around the vehicle. Rather, in the event of a spill, the product shall be directed to a containment area adjacent to the service location. Specific local regulatory requirements for systems at each specific ANG location shall be followed.

10.24. NATURAL GAS:

10.24.1. All interior gas lines shall be routed above grade. In no circumstance shall any gas line pass under or enter a facility from under the floor slab. All above floor gas line, not directly exposed, (concealed or difficulty to gain access to) must be of welded connections. Threaded gas line fittings are not allowed.

10.24.2. All gas line connections to each item of equipment or appliance must include a dirt pocket preceded by a shut off valve.

10.24.3. Gas lines at facilities:

Above grade, seamless black steel ASTM 53A.
Below grade, non-metallic conforming to local gas utility code and AGA.
No gas lines are to be buried under any facility.

10.24.4. Facility service gas system. Each facility shall have a facility exterior AGA approved block shut-off valve, pressure gauges, a regulator and facility gas meter. Provide full line size gas bypass, with double block shut off valves, of meter to allow meter servicing without facility interruption. Bypass valves shall be locked. Meter shall be located on a concrete house pad that extends from the facility wall to completely underlie all gas piping and appurtenances. Gas service entrance to facilities shall not be on front or highly visible sides of facilities and shall be screened architecturally regardless. Generally, service entrances shall be from within the mechanical courtyard. Provide above grade penetration through facility wall into mechanical spaces and provide brass escutcheon at exterior sleeved penetration.

10.24.5. Interruptible gas supply. Bases and facilities which are serviced by interruptible gas supply contracts, shall be provided with dual fuel systems. The back up dual fuel source shall either be oil or propane systems. Back up fuel capacity shall be sized for not less than 10 days of operation.

10.25. OPERATIONS AND MAINTENANCE MANUALS:

10.25.1. Specifications shall be very concise and comprehensive regarding requirements for project Operations and Maintenance Manuals. Manuals shall meet the requirements outlined in ASHRAE Applications Handbook, Chapter 35 and the Systems Handbook, Chapter 39. Standardize O&M manual requirements among project specifications to the fullest extent possible. Review other new base O&M manuals for examples of previous standards. Manuals shall include original data on all materials, systems, components and equipment provided for the project. Manuals shall be professionally prepared, including printed spine and cover with full table of contents and tabbed indexing. Full size sheets, if required, shall be folded into special holding pockets. All manual data shall be original copy. Faxed, hand written or illegible material is not acceptable. Typically, manuals are prepared in three ring binders for ease of document addition or removal. O&M manuals shall be completed, submitted and approved by no later than 75% construction complete. Two copies of final manuals shall be provided to the BCE. One copy is for file and the other will be located in the contract furnished O&M manual lock box in each mechanical room.

10.25.2. Manuals will be required to include among other things:

a. Include full instructions on lubrication, servicing and maintenance scheduling
b. Include operating instructions including start up, emergency shut down and start-up, seasonal servicing and start up, etc.
c. Include owner's manuals for each item of equipment
d. Include final certified TAB report
e. Include all equipment wiring diagrams
f. Include all HVAC control diagrams
g. Include all HVAC systems diagrams and operational diagrams
h. Include full parts lists and exploded schematic diagrams
i. Include backflow prevention device certification and yearly certification requirements per local code.
j. Include full warranty information
k. Include full names, addresses, phone numbers, suppliers, service companies, contract numbers and other points of contact/information relative to the job
l. All control termination points must be permanently labeled and labeling documented at the panel and in the O&M manual

10.26. POSTED OPERATIONS INSTRUCTIONS:

10.26.1. Specifications shall be very comprehensive concerning the requirements for Posted Operations Instructions. Standardize Posted Instruction format and requirements among project specifications or conform to existing base standard. Instructions shall be required to be completed with professionally prepared graphics, printed on full size sheets and shall be in color.

10.26.2. Posted Instructions shall be prepared for all mechanical systems and shall include all components.

a. Comprehensive schematics for air distributing and handling systems
b. Facility floor plans showing location of all equipment with coordinated identification.
c. Piping diagrams (hot, cold, heating, chilled, compressed, fire, other
d. System diagrams, including isometrics of equipment and systems (boiler, pumps, chiller, AHU's, VAV's exhaust systems, etc.
e. Valve charts
f. Equipment schedules

10.26.3. Posted instructions shall also include full control diagrams, which will include the following:

a. Sequence and control sequence of operations diagrams.
b. Point's lists must be included. The point's list shall include all defined PI/AI/AO/DI/DO points along with a specific sequence of operations.
c. Schematic HVAC systems and operations diagrams showing piping and ducting systems relative to each major item of equipment.
d. All control termination points must be permanently labeled and labeling documented at the panel and in the posted instructions.

10.26.4. Instructions shall be framed in extruded metal frames, mounted under glass. Instructions will be permanently mounted in the clear wall area reserved in each mechanical room.

10.26.5. For those bases with active EMCS system an excellent alternative for facility posted operations instructions is to include them as part of the EMCS database. Posted Instruction information may be prepared in word and graphics format and incorporated into the base EMCS system PC graphics, point and click system. All systems diagrams, floor plans, systems details and operations text can be prepared in formats suitable for a PC system and can be detailed into the base central EMCS database for ease of use.

10.27. TRAINING:

10.27.1. Specifications shall be very thorough concerning requirements for Training of personnel on all systems. A complete mix of on-site, classroom and off-site training shall be specified for all equipment and systems. Training shall be specified to be complete with all materials, fees and tuition covered by the contract. (only employee travel costs shall not be covered by the contract) Training shall be provided by factory instructors or factory trained and authorized instructors. Specify clearly the number of hours of training and the number of personnel to be trained. Clearly indicate what systems and components are to have training on. Include all training requirements in one location in the mechanical specifications.

10.27.2. The base DDC and EMCS systems shall require training on a facility by facility basis and shall include a minimum of 80 hours of training per facility. Training shall also be provided on a base wide system basis and shall include a minimum of 160 hours of on site training for the base wide system. Additionally a minimum two week off site factory school training session for no less than two individuals shall be provided for new base EMCS systems.

10.28. HVAC COMMISSIONING AND ACCEPTANCE:

10.28.1. Specifications shall be very thorough concerning the requirements for checklists and commissioning and acceptance procedures for the HVAC systems. Checklists shall be comprehensive and based on standards such as ASHRAE and ASME. Commissioning and acceptance checklists shall be part of the acceptance procedure for any facility and shall be completed by the contractor. Checklists shall be submitted prior to substantial completion inspections.

10.28.2. Initial start-up and pre-operational checkout of large equipment shall be handled by a factory-authorized representative, especially for larger air conditioning systems (I.E. 20 ton chillers and over).

10.28.3. Part of the commissioning and acceptance process shall include the use of an independent Associated Air Balance Council (AABC) certified testing and balancing contractor. All HVAC testing and balancing work (TAB work) shall be in accordance with AABC criteria. TAB work shall be completed with full coordination of the mechanical contractor and the controls contractor. All TAB work shall be completed prior to substantial completion inspections.

10.28.3.1. Require that the TAB contractor guarantee work and reports per the testing association standards.

10.28.3.2. Testing and balancing shall be performed on both new and existing systems including:

a. Hydronic test and balance on chilled water cooling systems
b. Hydronic test and balance on hot water heating systems
c. An air test and balance on forced air heating or cooling systems
d. An air test and balance on exhaust air systems
e. Other systems

10.28.4. Another part of the commissioning and acceptance process shall include the provision of full DDC system verification. Verification test forms shall be prepared and completed for all systems such as AHU's, chillers, pumps, boilers, VAV's, exhaust fans, etc. Verification shall include demonstrated operations of all equipment as well as seven day trending reports that show all systems operating a optimum performance levels. All verification and documentation shall be completed prior to substantial completion.

10.28.5. Require the Contractor to notify Contracting Officer and allow a Government construction inspection of all systems and components located above ceilings and behind walls before walls are closed and ceilings are installed.

10.29. ENERGY MANAGEMENT AND CONTROL SYSTEM (EMCS) AND DIRECT DIGITAL CONTROL (DDC).

10.29.1. All ANG facility and site projects shall provide or expand on the base EMCS control system. All ANG facility HVAC systems shall use complete DDC controls. The following section shall be used as guidance. In general, the EMCS system shall encompass the following type of uses: utility monitoring, lighting control, HVAC equipment control, and specialized systems monitoring. In the ANG, an EMCS is generally not used for liquid fuels system monitoring, fire detection systems or security systems. These items are covered by separate systems.

10.29.2. Basic Requirements:

10.29.2.1. An EMCS using DDC is recommended for each distinct facility when larger than 110 SM (1,200 SF). Justification of EMCS in smaller facilities should be based on need, economical feasibility, whether a monitoring a critical process, useful need, or other basis.

10.29.2.2. All HVAC equipment greater that 20 KVA or 25,000 BTUH input shall have physical access provided and EMCS monitoring of input/output/operating conditions. Justification of EMCS at smaller loads should be based on need, economic feasibility, whether monitoring a critical process or other basis.

10.29.2.3. In facilities with loads greater than 150KVA or 500,000 BTUH, an EMCS should measure energy use and performance for individual occupancy, but also should separately monitor process or consumption, which exceeds 100KVA. The following are examples and are not comprehensive:

a. Production processes including Kitchens, Avionics, Simulators, etc.
b. Auxiliary systems and hot water service.
c. All HVAC equipment and systems.

10.29.2.4. EMCS systems shall remotely monitor base utilities at main base utility service entrance, at major points of utility use, at individual facility service entrances and at facility sub-meters. Utilities to be monitored shall include but are not limited to; gas water, and electricity.

10.29.2.5. Each public utility meter must be fitted so that the meter can be remotely monitored, by the EMCS.

10.29.2.6. Arrange energy delivery systems to allow measurement of occupancy lighting and outlets, auxiliary systems, hot water service and Heating, Ventilating and Air Conditioning.

10.29.2.7. Avoid having more than one type/brand of DDC per local ANG installation

10.29.2.8. Existing Systems: If a specific brand name of EMCS (DDC) system is currently in use and has been declared the base system, all new installations shall be compatible with that existing system brand. The design shall define the interface and compatibility.

10.29.2.9. New Systems: The first DDC system on base will likely define the base system. The selected system should be able to accept upgrades and interface with future versions by the same manufacturer, without replacing the hardware, control modules, processors, gateways, or sensors. System upgrades ideally should only require upgrades in software. Upgrades should NOT require changes in hardware or complete new software versions of the same system.

10.29.3. Scope: Determination of the limits of scope of the base EMCS system shall be made by the A-E.

10.29.3.1. Evaluation shall be made but not be limited to the following systems:

a. Air system equipment including air handling units, VAV's and fans
b. Hot water and steam systems including boilers
c. Air conditioning system equipment and components including packaged units, DX units, condenser water, cooling towers and chillers
d. Hydronic pumps and flow measuring stations
e. Frequency drives
f. Lighting control including interior, exterior and aesthetic
g. Monitoring utilities including master meters and sub-meters
h. Back up Generators

10.29.4. EMCS/DDC Design Criteria. The A-E must clearly define the level of control of each system within the expected EMCS scope, with particular attention to the HVAC systems.

10.29.4.1. For existing system(s) and facility(ies), conduct an initial survey of existing HVAC and electrical systems and facilities and decide which systems and subsystems should be controlled or monitored by DDC.

10.29.4.2. For new or existing systems, select and solidify the limits and requirements of the EMCS.

10.29.4.3. A point list shall be determined including: Pulse In (PI), Analog Out (AO), Digital Out (DO), Digital In (DI) and Analog In (AI). Development of detailed lists of (PI/AI/AO/DI/DO) points for each connected system or facility within the scope of the project is required.

10.29.4.4. Include development of specific sequences of operational control for each connected system.

10.29.4.5. Provide for the development of scenarios for electrical demand side management, equipment duty cycling, load shedding, back up generators, and back up fuel supply. Services may require coordination with local utility companies.

10.29.4.6. Include any necessary follow up'verification & investigation of existing & planned HVAC systems within the scope.

10.29.5. Generally the design of DDC/EMCS systems shall include the following:

a. Incorporate state of the art direct digital control and be compatible to and integrateable with protocol of existing systems (if any) on base.
b. Must completely interface with current base EMCS network (if any).
c. System must be expandable and able to fully accept upgrades to future DDC systems in other facilities on base.
d. Interface with duct-mounted smoke detectors and separate fire alarm panels (by others), for shutting down HVAC in emergency conditions.
e. Interface with planned or existing boilers and modular boilers in a staged sequence for efficient partial load matching.
f. Status and start/stop control of electric motor on pumps, fans, air conditioning units, & air handling units, VAV's and other HVAC equipment.
g. Monitor and control hydronic systems, including valves, flows, temperatures pressures.
h. Monitor and control air handling systems, including dampers, flows, filters, temperatures and pressures.
i. Monitor and control all direct gas fired units such as infrared heating.
j. Monitor and control other HVAC systems such as evaporative coolers.
k. Provide control of building lighting and exterior lighting for energy management & control.
l. Be generously expandable, and capable of networking with multiple future DDC systems in other facilities.
m. Utilize the latest versions and models by the manufacturer. Avoid any older software, software versions, or hardware.
n. Monitor all base and facility metering.
o. Other functions.

10.29.6. The final design specifications shall include complete detailed facilities and graphics to be developed by the vendor under contract. Do not attempt to task the time of base personnel with this requirement. Adequate provision for personnel training shall be included. Specify the number of hours, who will provide it and where it will be held. The A-E shall develop and include commissioning plan. The plan shall ensure operation of the connected HVAC, electrical, and other systems are in compliance with the specified design, and are with the normal operating range of the HVAC and electrical equipment. Develop a complete final list of (PI/AI/AO/DI/DO) points for each connected system or facility. Incorporate final sequences of operational control for each connected system.

10.29.7. Features and Functions:

10.29.7.1. The EMCS system shall remotely control & monitor base (HVAC) (Lighting) (Utility) (Other) systems from a new or existing 'central site' PC.

10.29.7.2. The head end of the operating system normally should reside at Civil Engineering.

10.29.7.3. The new system shall be capable of complete and seamless interface with existing systems; e.g., must communicate completely with existing DDC system, shall share all monitored information, and have state of the art features. System must also be completely backwardly compatible with previous version of the same operating system, regardless whether a DOS, Windows, or other platform is used.

10.29.7.4. Systems shall be based on local CE needs and shall give consideration and evaluate any benefit or need for requiring a true native protocol, i.e. BACNET, LONWORKS.

10.29.8. The operating system should amply include following features:

a. Trending feature for data collection, analysis, and to support trouble-shooting features.
b. Weekly/monthly/yearly data totalizing, and Historical Data Archiving.
c. Alarm or alerting for sending, receiving, recording, relaying, and archiving alarms.
d. Messaging feature for automated routine messages and maintenance reminders.
e. Scheduling feature for supporting facility occupancy and managing equipment starts, run times and schedules.
f. Utilities monitoring and analysis functions.
g. Optimizing features start/stop functions.
h. Override features.

10.29.9. Provide one copy of the vendor's draw package which will likely reside on the main PC located in CE.

10.29.10. Include full warranty and service: Assume maintenance staff will require 1 to 2 years to be fully operational and supportive of the EMCS.

10.29.11. The DDC operating system shall be as user friendly as possible. Point and click on graphics are the standard requirement. The system must support easy and comfortable graphical user interface (e.g. user friendly, good graphics, point and click operation with a mouse, etc.).

10.29.12. Communications. The EMCS system will interface and communicate with the software resident at head end operating system at the central site PC station. Determination must be made on how to connect the EMCS network together. Viable options include base LAN fiber optic lines, telephone modems, hard wire copper lines direct connections, radio transceivers, the Internet, and twisted shielded pairs for short distances. For new installations, use of dedicated Ethernet fiber optic lines is the recommended method.

10.29.12.1. The Base Civil Engineer in conjunction with base Communications Officer must make a deliberate decision on how to connect the EMCS systems. Determining the optimum way for building communication on a base-wide network shall be coordinated with the design engineer, base civil engineering personnel, and base communications. Communication via existing or new fiber optics, if lines are available is recommended. Fiber optics are preferred, but it is recommended to not piggy back on the base LAN system. Connecting the system via fiber optic lines is best done on spare, separated fiber optic lines, dedicated only for EMCS use.

SECTION 11 ENERGY CONSERVATION CRITERIA

11.1. INTRODUCTION: Executive Order 13123, Greening the Government Through Efficient Energy Management, requires that all Federal facilities reduce energy consumption per gross square foot, by 30% by the year 2005 and by 35% by the year 2010. This executive order also mandates a reduction in green house gas emissions that are attributed to energy usage by 30% by the year 2010 as compared to a base line of emission levels in the year 1990. ANG facilities shall comply with these requirements.

11.1.1. All facilities shall include state-of-the-art energy conserving design features, which are shown to be cost-effective. These features shall be incorporated and discussed at the Concept Development Meeting and verified at the Contract Documents Development Meeting. As a minimum, criteria identified in the applicable portions of accepted standards shall be considered. At each applicable stage, the A-E shall identify the criteria that was specifically considered.

11.1.1. The facility portion of "The Energy Policy Act of 1992" shall be evaluated and incorporated by the Concept Development Meeting unless ANG criteria are more stringent.

11.1.2. ASHRAE Standard 90.1, "Energy Efficient Design of New Buildings Except New Low-Rise Residential Buildings," and the Department of Energy (DOE) "Federal Energy Standard" shall be considered and incorporated by the Concept Development Meeting, unless ANG criteria are more stringent.

11.1.3. State or Local criteria shall also be considered and incorporated by the Concept Development Meeting, unless Energy Policy Act, ASHRAE, DOE or ANG criteria are more stringent.

11.2. ANG CRITERIA: Energy conservation criteria identified in ANG ETL 93-1, "Energy Conservation Criteria," shall be incorporated in all facilities, without economic evaluation, unless the designer demonstrates that they are not economically justified, based on a 25-year facility life. Documentation shall be provided at the Concept Development Meeting. Note that incorporation of the U-values shown in section, "DESIGN CRITERIA ON U-VALUES" in this Tab, is mandatory.

11.3. NON-STANDARD CRITERIA: The designer is encouraged to identify energy-conserving criteria which exceed those resulting from consideration of the above paragraphs of this section, and shall provide an economic justification at the Concept Development Meeting. The analysis should be based on the approaches and methods of ANG ETL 91-7, "Life Cycle Cost Analysis - Energy and Non-Energy Projects," or on methods shown to be equivalent.

SECTION 12 SOLAR ENERGY SYSTEMS

12.1. ACTIVE SOLAR SYSTEMS:

12.1.1. All project designs shall include evaluation of the application of solar domestic water heaters when weekday daily average consumption is 302.8 liters (80 gallons) or more, using 7.6 liters per day per person (2 gpd/person) for hand-washing. Additionally, consider application when use of 56.8 liters per day per person (15 gpd/person) for showering is a functional requirement. The project book's facility description indicates the facility's daily occupancy.

12.1.2. Solar domestic water heaters are not to be installed for periodic or intermittent process use. They shall not be installed for aircraft washing, dining hall or kitchen use.

12.1.3. If a solar domestic water heater is provided, it shall be connected together with a conventional water heater.

12.1.4. Solar water heating units selected shall be packaged, off-the-shelf equipment.

12.1.5. Feasibility will be established if the discounted payback is 25 years or less. In accomplishing a life cycle cost analysis, use 90 percent of the installation cost and the principles and procedures of ANG ETL 91-7, "Life Cycle Cost Analysis - Energy and Non-Energy Projects." Provide the analysis at the Concept Development Meeting.

12.1.6. Use realistic maintenance and repair costs using sources such as ASHRAE Handbook, HVAC Applications, Chapters 30 and 33.

12.2. PASSIVE SOLAR SYSTEMS:

12.2.1. Designs must include consideration of the potential advantage of passive solar features. The U.S. Air Force "Passive Solar Handbook," Volumes I, II and III, is available through the base civil engineer and should be consulted for accepted guidance. Passive designs may entail higher construction costs than those of conventional designs.

12.2.2. To be considered for inclusion, the designer must show that the additional cost of passive systems can be recovered indirectly from reduced fossil fuel and/or electrical costs within 25 years. For all new facilities as a minimum, the designer shall evaluate all potentially feasible passive solar features. The evaluation shall be accomplished at the concept stage and shall be presented at the Concept Development Meeting.

12.2.3. The evaluation must be of sufficient detail and provide a clear and effective basis for comparing passive and non-passive designs.

12.2.3.1. Provide an economic analysis of conventional systems in accordance with Section 3 of this Tab, "ECONOMIC ANALYSIS".

12.2.3.2. Provide an economic analysis of passive solar systems and compare the results with the most cost-effective conventional design.

12.2.3.3. If orientation of the structure to the sun is different than it would otherwise be without passive design considerations, provide a site plan for each building orientation and show the additional site work cost of one plan compared to the other.

12.2.3.4. Passive solar design may include both solar heating and cooling.

12.2.4. The passive solar features shown in ANG ETL 93-1, "Energy Conservation Criteria," are considered to be "conventional" and do not require a life cycle cost analysis.

SECTION 13 ENERGY BUDGETS

13.1. INTRODUCTION: All facilities shall be designed to operate over an annual cycle within the Target Design Energy Budget shown in this section.

13.2. GUIDELINES FOR ESTABLISHING AND EVALUATING ENERGY BUDGETS: ANG ETL 93-2, "Energy Budgets and Component Efficiencies," is the source for obtaining the project's Target Design Energy Budget. This document shall also be consulted for additional guidance concerning energy conserving design. Additionally, information can be obtained from the following locations:

U.S. Dept. of Commerce, Weather Bureau; American National Standards Institute; Uniform Building Code, AFH 32-1163, Engineering Weather Data. This can be found at http://afpubs.hq.af.mil/, Electronic Publications, United States Air Force, Series 32, then chronically listed by suffix number, 32-1163.

Alternatively, it can also be found at the AFCESA web site: http://www.afcesa.af.mil/, Library / Publications, Draft Publications List, under Draft Air Force Handbook (AFH). Information is listed by IP (inches, pounds) and by SI (metric).

13.3. DOCUMENTATION: ANG ETL 93-2 provides the format and all information required for calculation and presentation of the Target Design Energy Budget and the actual Design Energy Budget. This information shall be provided in the format offered below, as part of the Contract Documents Development Meeting. This information must be approved by the Base Civil Engineer. This information shall also be included as part of the pre-final design submission package, submitted to HQ ANG/CE, in accordance with information contained in this ETL.

ANG FACILITY ENERGY BUDGET ANG DESIGN DATA

BASE: _____. **STATE:** _____.

LOCATION: _____. **NEAREST DATA POINT:** _____.

DOMESTIC HOT WATER DESIGN TEMPERATURE: (At Point of Use:) 92 ^{O}C (110^{O}F)

DESIGN DATA:

a. Heating Degree Days (HDD): _____.

b. Cooling Degree Days (CDD): _____.

c. Outside Design Temperature:

(1) Heating (97.5%): _____^{O}C.(^{O}F)

(2) Cooling (2.5%):

(a) Dry bulb: _____^{O}C.(^{O}F)
(b) Wet bulb: _____^{O}C.(^{O}F)

(3) Dry Bulb Hours Greater Than 62^{O}C (80^{O}F) = ____ HRS.
(If 350 or greater, air conditioning in offices for personal comfort is authorized.)

d. Seismic Zone (UBC Definition): ___.

e. Wind (ANSI/ASCE 7-88):

(1) Peak Velocity: _____ Meters per Second (MPH).

(2) Mean Speed: _____ Knots.

(3) Prevailing Direct: _____. (Direction)

f. Roof Snow or Live Load: _____ Kilograms/Square Meter (Lbs./SF).
(Use local code if more stringent)

g. Max. Frost Penetration: _____ Centimeters (Inches). (Use local code if more stringent)

h. Required Design to Energy Budget: _____ BTU/Square Meter - Year (BTU/SF-Yr).

i. Actual Facility Project Design Energy Budget: _____ BTU/Square Meter - Year (BTU/SF-Y

END

SECTION 14 UNDERGROUND AND ABOVEGROUND STORAGE TANKS

14.1. GENERAL: The information contained in this section shall be used with all designs which have tanks containing petroleum products, tanks covered by 40 CFR 280, or oil/water separator systems.

14.2. TANKS: All new tanks containing petroleum products shall be designed and constructed aboveground unless otherwise approved in writing by ANG/CE. The only exception to this policy is for oil/water separators and their associated oil holding tanks. All associated underground piping required shall be constructed of double wall pipe and sloped to provide for manual monitoring access.

14.3. OIL/WATER SEPARATORS: Oil/water separators and their associated oil holding tanks shall be of double wall construction. Systems shall be provided with monitoring and shall have spill protection. If at all possible, the oil holding area shall be contained within the separator and shall be less than 416 liters (110 gallons) in capacity. Tanks of steel construction shall have cathodic protection provided in accordance with NACE criteria and provisions found in Section 16 of this Tab, ELECTRICAL REQUIREMENTS, . Emergency oil/water separators which do not normally contain product, do not normally require double wall construction. These separators are of the type and use that are not connected to systems, floor or area drains, or which can receive a continuous source of product.

14.4. DESIGN: Aboveground tank systems (regulated and non-regulated) must address the following requirements:

14.4.1. Secondary Containment Systems. When secondary containment is required (generally for tanks over 2498 liters (660 gallons)) the tank and containment shall be a integral manufactured system. The storage tank shall be a shop fabricated steel tank and a steel containment dike with rain cover shall be included. The tank system shall not be field fabricated. All tank piping and associated product containing parts must be provided with secondary containment. The steel tank and dike system shall be primed and painted with corrosion protective paints. Tank final finish painting shall be of polyurethane coatings, with colors selected to match the base's architectural color theme.

14.4.2. Safety items shall include stairs, platforms, rails and identification systems. Tanks shall be provided with all manufacturer safety items for tank use and maintenance access. All access safety items shall either be of complete hot dip galvanized finish, or finished to match the storage tank itself. Reference Section 17 of this Tab, SAFETY, for additional information.

14.4.3. Identification. All tanks installed shall have a mechanically affixed, engraved metal identification plaque. This plaque shall contain information including, tank capacity, date of tank installation, installation contractor and type of material contain within.

14.4.4. Protection and Screening. All tanks shall be installed on appropriate concrete house pads of dimension larger than the tank system (tank, dike, stairs, etc) itself. Concrete pad shall have broom finish and chamfer edge. All tanks shall be concealed and protected with masonry walls and/or fencing systems with gates that match or are architecturally compatible with the associated facility. Area within tank enclosure shall be concrete finished. Tanks installed in any location with vehicle access shall have appropriately located six-inch, concrete filled bollards provided for tank protection.

14.4.5. Additional Pumping Systems. These systems are only required if Defense Fuels Supply Center (DFSC) cannot supply the product to aboveground tanks without additional pumping. If storing several differing products, pumps for each product shall be provided to avoid mixing and cross contamination.

14.4.6. Clearances and distances. Reference Section 17 of this Tab, SAFETY, for building separations or existing building modifications. Tanks shall not be installed in any location where the tank is farther than 15.2 meters (50 feet) from vehicle access pavements.

14.4.7. Associated Underground Piping. All product containing piping shall be constructed of double wall pipe and sloped to provide for manual monitoring access.

> Note: Both the National Fire Protection Association (NFPA) and the Uniform Fire Code (UFC) have made provisions for aboveground gas station tanks.

14.5. WASTE AND USED OIL STORAGE: Petroleum waste and used oil storage shall utilize a 208 liter (55 gallon) drum system, if possible, to avoid becoming a large quantity generator or an accumulation point. The tank collection and storage site shall be constructed as a dyke concrete storage pad with containment liner placed under the concrete construction. The dyke area should have concrete ramps for access and dyke edges should not be less then 15.2 cm (6 inch) width reinforced concrete. Pre-manufactured plastic or fiberglass storage systems and containment basins are also available alternatives. Weather cover (roofing without sides) may be provided depending on geographic location and use. Larger storage systems require special handling and permit procedures and so should be avoided when possible. If in the BCE's and Base Environmental Managers opinion, a larger volume of waste oil storage or larger collection tank is required, they shall contact ANG/CEVQ for guidance. For any other questions on waste oil collection, contact ANG/CEVQ. Waste and used oil tanks shall be aboveground tanks and are not to be confused with the oil holding or collection tanks used with an oil/water separator.

SECTION 15 FIRE PROTECTION

15.1. INTRODUCTION:

15.1.1. Air National Guard fire protection policy is based on the principals of developing an integrated system of balanced protection, which selects options from current technology and which applies the most advantageous design features and systems. These selected features and systems are carefully engineered to reinforce one another and to cover for one another in case of the failure of any one system. The process of achieving that integration, balance and redundancy to attain fire safety objectives is the essence of fire protection engineering, including codes and standards. Air National Guard policy also looks to the designer to develop and select from options which provide the greatest protection and coverage with economy in mind. Additionally, ANG fire protection systems must be designed for maximum reliability, accessibility and maintainability.

15.1.2. Deviations from, additions to, or interpretation of ANG fire protection policy and requirements or codes and standards can only be obtained from the Fire Protection Program Manager at ANG/CE.

15.1.3. In the event that discrepancies arise between Regulations and Technical Letters, the following general hierarchy shall be used by the A-E.

- Air Force Technical letters overrule NFPA Standards.
- Air National Guard Technical letters overrule AF Technical letters and NFPA Standards.

15.1.4. All design projects which involve or impact fire detection and suppression systems for ANG facilities, including renovation, repair, maintenance and new construction require the designer (A-E or in-house) to have on staff or under contract a qualified and experienced Fire Protection Engineer (FPE). It is the FPE's responsibility to develop the specific requirements of the fire protection design and to seal that portion of the design. Although required for all projects, this requirement is particularly important for those involving the design of aircraft hangar fire suppression systems. For the purpose of meeting qualification requirements, a qualified FPE is defined as an individual meeting one of the following conditions:

15.1.4.1. Bachelor of Science or Master of Science degree in fire protection engineering from an accredited university, plus a minimum of 5 years' work experience in fire protection engineering.

15.1.4.2. Professional Engineer (PE) registration by examination, National Council of Examiners for Engineering and Surveys (NCEE) fire protection engineering written examination.

15.1.4.3. Qualification as a GS/GM 804-series FPE.

15.1.4.4. PE registration in a related discipline with a minimum of 5 years' work experience in fire protection engineering.

15.1.5. All fire protection construction projects and especially those involving the construction of aircraft hangar fire suppression systems, shall have specified requirements that require the contractor (prime or sub) have on staff or under contract a qualified and experienced FPE. This person(s) shall be responsible for performing and overseeing all engineering aspects of the fire protection system construction, including but not limited to, calculations, layout, shop drawings, equipment selection and inspections. In addition, this person(s) shall be responsible for the testing plan and for final commissioning and testing of the system. ANG contract documents (plans and specifications) shall clearly outline the qualification requirements contained herein. For the purpose of meeting qualification requirements, a qualified FPE is defined as an individual meeting one of the following conditions:

15.1.5.1. Bachelor of Science or Master of Science degree in fire protection engineering from an accredited university, plus a minimum of 5 years' work experience in fire protection engineering.

15.1.5.2. Professional Engineer (PE) registration by examination, National Council of Examiners for Engineering and Surveys (NCEE) fire protection engineering written examination.

15.1.5.3. Qualification as a GS/GM 804-series FPE.

15.1.5.4. PE registration in a related discipline with a minimum of 5 years' work experience in fire protection engineering.

15.1.6. Construction of all fire protection systems (suppression and detection) is intended to be of the design-build nature, wherein the construction contractor is given all performance requirements, standards, quality expectations and data necessary for provision of the specified systems. The contractor will use this information to design (hydraulic calculations, shop drawings, equipment selections, equipment location and layout, trade coordination, etc.) and to provide the actual systems. Generally, do not provide sprinkler system piping and head layout design in the construction plans. Do provide comprehensive layout or locations of all required detection devices in accordance with standards outlined in this ETL and per NFPA criteria. The outline device locations shall not limit the contractor, who shall be provided full specification as to the standards and requirements for device locations and the requirements thereto so that the contractor can properly develop the required shop drawings. For both suppression and detection systems, provide full specification as to the standards and requirements so that the contractor can properly develop the required shop drawings. Utility provision, water storage, alarm riser, High Expansion Foam (HE) system equipment and fire pumps are exceptions and shall be fully designed by the A-E.

15.1.7. Active fire detection and protection systems include automatic detection and notification systems, which tend to activate first, followed by automatic suppression systems, such as sprinklers and/or monitors.

15.1.8. Passive fire protection systems are designed to confine fire and smoke in zones and provide the automatic systems with a manageable fire to act on. Special attention is to be given to the spaces through which occupants will move to safety and the protection of the building's structural integrity.

15.1.9 . Specifications shall clearly require contractor submission of all required documents, test results, drawings and manuals. Examples include, but are not limited to, NFPA 13 and 72 forms, as-built drawings, complete O&M manuals, testing and commissioning plans and final reports, etc.. These documents shall be required to be submitted a minimum of 30 days prior to the expected scheduling of Final ANG Acceptance Inspections/Testing and Commissioning. The documents shall be provided as a submittal for review and approval and acceptance inspections/testing will only be scheduled upon approval of the submission documents.

15.2. AUTOMATIC DETECTION AND NOTIFICATION SYSTEMS:

15.2.1. Unless otherwise noted, systems shall meet the requirements of the most recent edition of the following publications: National Fire Protection Association (NFPA) 70, 72, 75 and 90A and 101.

15.2.1.1. Provide separate fire protection (FP-__) drawings in the plan sets. The minimum design drawing requirements for detection systems are as follows: occupancy hazard classifications, graphically depicted locations of all fire rated walls with rating indicated and locations of all devices on a dedicated floor plan and location of fire alarm control panel and annunciator panel. Also show the suggested routing for all fire system conduit. In addition, provide a riser diagram that clearly defines the individual zones and devices as well as clearly showing all connections "by others".

15.2.2. Unless suppression systems are provided, a complete facility or complex automatic fire detection system and fire extinguishers constitute the minimum level of acceptable fire protection for all new and major renovation construction. The table matrix found at the end of this section provides additional information concerning the minimum level of detection/suppression required for all ANG facilities. Systems design shall follow hazard classifications of the NFPA and conform to criteria of the UBC.

15.2.3. All occupied and unoccupied spaces of all facilities shall be protected with an automatic detection systems. Smoke (duct) detectors in return air plenums alone, do not meet this minimum level.

15.2.4. Facility fire detection and alarm systems shall consist of automatic smoke and heat detection systems and manual pull stations for each facility. The system shall provide local audio and visual alarm throughout the facility interior and exterior. The system shall also provide radio based, fiber optic or landline based remote system reporting to the base central system and a secondary central receiver. Provide radio based transmission systems for all new base-wide systems. Match existing standard for construction of new facilities with an existing base system. All facility fire systems must also transmit appropriate signals to the responding (host or other) fire department, which in most cases is not the ANG fire station.

15.2.5. Base central automatic fire alarm receiving and reporting systems are required and provide for the transmission/receiving of coded fire, emergency (eyewash station, POL, VMF or Fuel Cell fuel leak detection, etc.) , trouble, tamper, Knox box, HVAC smoke detector, system restore signals, manual pull station activation, suppression system activation, flow alarm, HE system activation and other information from all base detection, alarm and suppression systems. Reporting shall report all information for each system by device where applicable, by zone and by system. A general fire or trouble signal is not an acceptable minimum. The base central system is generally located in the responding (ANG or Host base) fire department alarm and communication center. The remote secondary receiver is typically located at 24-hour manned Security Forces or Command post. The system shall also report all information to the facility local annunciator which is to be a recessed panel type, located internally, near the primary facility entrance. Provide built in casework and workstation for the receiving systems in both the fire station and the security or command post. Receiving system shall be PC based, complete with all programming, graphics, etc.

15.2.6. All new systems shall be compatible with existing base systems, as to brand and models of panels and transmission system. All new systems shall be capable of reporting properly to the base central systems.

15.2.7. All detection and alarm systems shall be of the 4-wire supervised type (Class A). All fire detection and alarm system wiring shall be run in minimum 1.9 cm (3/4 inch) EMT conduit complete and shall be clearly identified.

15.2.8. Manual fire and evacuation alarm systems (pull stations) are to be provided in all facilities regardless of other systems provided and shall provide both local audio and visual alarm as well as remote annunciation as outlined herein. Manual systems shall be provided at all exits (swing, roll back and roll up door type), along paths of egress, on every floor, in occupied and unoccupied spaces, in shops and storage spaces and in other locations where logical to incorporate. Provide manual pull stations in unobstructed locations. Do not provide for installation on the hinged side of doors except in the case of double doors. These systems may not be used in lieu of automatic detection systems, but they are required to supplement certain suppression systems.

15.2.9. All detectors shall be of the heat type, except in sleeping quarters, exit corridors and ducts where heat/smoke type units are required. Provide heat/smoke detectors in all exit corridors. Provide automatic heat detectors in storage and electrical/communication /mechanical areas as well as occupied spaces. For open office, systems furniture areas, provide a heat/smoke detector at close proximity to each space exit door. For raised floor systems areas, provide heat/smoke detectors below the raised floor panels. Detectors shall be provided for all concealed spaces (such as above drop ceilings) and such detectors shall be identified and each shall have a remote LED indicator visible from floor level. Use NFPA 72 for guidance.

15.2.10. Provide duct type smoke detectors, complete with fan shutdown relays (manual reset) for all air handling systems over 56.6 cubic meters per minute (2000 cfm). Provide detectors for both supply and return duct systems. Provide duct smoke detectors in accordance with NFPA 90A for HVAC systems. At all locations that a duct detector is installed, provide remote test switch (install at 2.1 meters (7 feet) above finish floor elevation) and LED indicator for maintenance and alarm identification.

15.2.11. The fire alarm control panel for each facilities detection system shall be located in either the fire protection room or the electrical room. Each facility shall be divided into multiple zones. Specific functions such as duct detectors, range hoods, eyewash stations and air-handling units equipped with duct detectors shall be wired as individual zones. Provide two or more spare zones depending on facility size. Facilities over 465 square meters (5,000 square feet) shall have a minimum of 4 spare zones provided. Facilities over 1858 square meters (20,000 square feet) shall have a minimum of 6 spare zones provided. The facility fire alarm system graphic annunciator shall be installed at a location determined by the host base fire department or other designated authority having jurisdiction. Typical location is interior, in the main facility entrance vestibule or hallway. All fire alarm system conduit in occupied spaces shall be recessed and not visible. The annunciator panel shall constructed with engraved phenolic or metal material, shall be recessed and shall graphically depict the facility floor plan with all zones and system information.

15.2.12. All detection and alarm wire shall be installed in separate conduits. Conduit shall be EMT conduit. Exception would be those locations deemed unsuitable for EMT conduit. In such cases, use Rigid or PVC type conduit. Minimum conduit size shall be 1.9 cm (3/4 inch) diameter trade size. Alarm and supervisory wiring shall be in separate conduits. Use of FMC or Liquid Lite is not permitted except in areas subject to extreme vibration. In those rare instances, no more than a six-foot length may be specified. All conduit runs and junction boxes shall be identified through color coding and labeling.

15.2.13. Wiring shall be THHN or TFFN stranded with crimp on terminal ends affixed. All terminal ends shall be clearly marked and numbered as to appropriate terminal and device. All wiring shall be color-coded and fully identified and standard throughout the facility. Use of multi-conductor twisted pair or similar wiring is not permitted. The use of wire nuts in fire protection systems is prohibited.

15.2.14. Fire Alarm panels shall be field expandable. Panels may be field programmable provided that this can be accomplished at the unit level, without the use of proprietary software, keys, the changing of electronic hardware, or use of any proprietary device. Any software, device, password or other element used to program any component of the fire system shall be specified to become property of the Government, along with the installed program. All panels shall include input and output modules and terminations for each four-wire (Class A) supervised zone. All zones to be annunciated to the central systems (two)(redundantly) for fire and trouble, on a zone by zone basis. All detection and suppression systems shall be simple and reliable. They shall use proven technology and shall avoid the use of proprietary or copy righted technology.

15.2.15. Fire alarm and suppression panels shall be complete from the factory and shall not require any field modifications or additions to perform the intended function.

15.2.16. Fire system battery systems shall be of the sealed gel-cell maintenance free type. Batteries shall be located upright, in the fire alarm panel and not in separate panels. Battery capability shall be capable of maintaining fire alarm operations for a minimum of 48 hours in the event of a power outage.

15.2.17. All facility fire system components shall be complete and shall be of the same manufacturer. Where the base has existing fire alarm systems, it is recommended that all new systems be of that same base standard manufacturer. Where possible, it is recommended that the system interface with base EMCS system for monitoring purposes only.

15.2.18. Systems shall utilize supervised, four wire (Class A) zoned wiring with non-proprietary generic type devices. Devices shall be interchangeable with other brands that are readily available.

15.2.19. Systems shall include full identification. All junction, terminal and pulling boxes and covers shall be painted the color red and shall be identified with engraved labels by the zone and circuit that it contains. All LB's and similar units shall be painted the color red. All detection and terminal devices shall have engraved plastic or metallic alphanumeric identification, which shall be keyed to the posted operations and maintenance instructions.

15.2.20. All panels and devices shall be UL or FM listed for their intended application.

15.3. AUTOMATIC SUPPRESSION SYSTEMS:

15.3.1. Unless otherwise noted, suppression systems shall meet the requirements of the following publications: NFPA 11, 11A, 12, 13, 14, 15, 16, 16A, 17, 17A, 18, 20, 22, 24, 25, 70, 72 and 409.

15.3.2. Automatic sprinkler systems can be wet pipe, dry pipe or pre-action and the design shall be based on the hazard involved. Deluge type systems are not authorized except in special applications as approved by ANG/CE. All new systems, for sprinklered areas over 278.7 square meters (3,000 square feet), shall be hydraulically calculated and designed to provide uniform discharge densities. Calculations shall follow the format of NFPA 13. Generally, provide wet pipe systems for all office, warehouse and shop areas (minimum criteria identified in following table). The systems shall be designed in accordance with NFPA 13. Generally, provide pre-action (dry) systems for computer and communication facilities (minimum criteria identified in following table). The system shall be designed in accordance with NFPA 13.

15.3.3. The table matrix found at the end of this section constitutes the minimum level of detection/suppression required for all ANG facilities. Where it is possible from an engineering capability perspective, economically feasible, common practice, a requirement of local area code or host base policy, it is strongly recommended that full facility automatic suppression systems be provided for all ANG facilities. Systems design shall follow hazard classifications of the NFPA and conform to criteria of the UBC.

15.3.4. Provide separate fire protection drawings (FP- __) in the plan sets. The minimum design fire protection drawing requirements for sprinkler systems are as follows: Provide occupancy hazard classification for each facility area. Show this information on a dedicated facility floor plan sheet and use a schedule and graphic symbols to differentiate between differing classification areas. Provide the discharge density/calculation area per hazard classification on the classification schedule. Also provide the sub or total design area in square meters and feet. Provide information on the fire protection sheets as to the size and location of incoming water supply, the point of connection to the base utility, location of individual sprinkler/standpipe riser(s), alarm valve riser diagram, fire department service connection and location of all control valves and main drains. Provide flow data to be used in the hydraulic calculations (see paragraph below) including flow in liters per minute (GPM), static and residual pressures and capacity/storage information. Fire protection systems, which include specialty systems such as kitchen hood protection, etc., shall include full design and details of that particular system. Fire protection systems which include Hangar suppression systems shall also include full design and details of the fire protection room, fire pumps, HE equipment and piping, etc. Sprinkler system layouts should not normally be included in the contract drawings. The sprinkler system contractor shall submit shop drawings.

15.3.4.1. The A-E shall perform flow tests at a minimum of two nearby base locations as part of the design process, to obtain accurate flow and pressure data to provide to the contractor. The specifications shall also require that the contractor provide their own confirmation flow testing.

15.3.5. Fire protection systems specifications for sprinkler, fixed HE and other protection systems shall include contractor qualifications/fire protection engineer requirements outlined in paragraphs above. Specifications shall also clearly contain complete requirements for the system testing and commissioning.

15.3.6. Following are listed important component details that shall be designed into all suppression systems.

15.3.6.1. All sprinkler system piping shall be minimum schedule 40 steel. All couplings in a facility shall be of one manufacturer.

15.3.6.2. All sprinkler system piping shall be finish painted in both occupied and unoccupied spaces. Paint red above ceilings and in concealed spaces and provide flow direction identification. Paint in facility coordinated color in occupied and exterior spaces. If not painted red, provide systems identification, which also indicates direction of flow.

15.3.6.3. Installation of cleated (screw type) flanges on all service piping is prohibited. Do not use victaulic type connections on the service side of facility alarm and isolation valve. Use only threaded or welded and flanged connections.

15.3.6.4. Service entrance piping shall be sleeved and sealed through the facility foundation and shall enter below grade through foundation into a concrete service entrance pit. Service entrance pipe shall not be set in direct contact with floor concrete. Thrust blocks shall be installed on underground piping at all changes in direction.

15.3.6.5. Provide dedicated fire service entrance with UL or FM listed back-flow prevention device and UL or FM approved indicating shut off valve. All fire service utility entrance shall be separate from facility domestic water supply utility entrance.

15.3.6.6. Sprinkler pendant placement shall be required to be carefully coordinated with all other trades. All heads shall be symmetrically placed in ceiling tile. Provide architecturally coordinated, single piece sprinkler trim rings in all occupied spaces.

15.3.6.7. Fire system exterior appurtenances shall be finished in either brass or factory finish red (Siamese, water gong, trim ring, etc.) per the base standard finish style. Exterior piping and related components shall be painted to match adjacent facility finish.

15.3.6.8. Use of water powered gong is preferred.

15.3.6.9. Sprinkler piping shall be capable of being fully and completely drained for maintenance purposes. Main drains and end of line drains to facility exterior shall be provided. Drains shall have cast in place concrete splash block or similar method to control runoff and erosion at the facility exterior.

15.3.6.10. A test valve (inspectors test station) shall be installed at the end of each wet pipe system. This connection shall be piped from the end of the most remote branch line. This connection shall terminate outside the facility. Provide smooth bore stainless steel orifice giving a flow rate equivalent to one sprinkler head. Installation at the riser is not acceptable.

15.3.6.11. No fire protection piping shall be installed over the top or within three lateral feet of any electrical panels, disconnects, transformers or other electrical devices. Provide heavy gauge galvanized steel hoods and shields (or stainless steel) that are shop fabricated for electrical rooms and communications rooms to protect the electrical equipment from water spray where a sprinkler system is installed. Drainage from these hoods shall be copper pipe, directed to floor drains.

15.3.6.12. Fire protection piping support shall be directly from the facility structural system. No other equipment or materials may be supported from the fire protection support system. Do not hang from the underside of roofing deck or from other equipment or materials. All support systems shall include full lateral and horizontal bracing. Design of support shall comply as a minimum, with seismic criteria as outlined in NFPA 13.

15.3.6.13. All system valves shall have tamper switches provided.

15.3.6.14. Emergency eyewash and shower stations shall be connected to the fire alarm system and shall report as a separate zone. These stations shall report as fire (or medical emergency if possible) and not as a trouble alarm.

15.3.6.15. All wall and floor penetrations with fire protection piping shall be fully sleeved and sealed. Sleeve shall be schedule 40 steel and protrude minimum of 10.2 cm (4 inches) on either side of wall surface with trim ring. Proper penetration detail and sealant shall be specified for penetrations of rated walls and floors.

15.3.7. All facilities with fire department service connections for sprinkler or standpipe systems shall be provided with suitable all weather ground surface for pumper apparatus access to the connection. Ground surface access shall be as close as possible and in no instance shall exceed 45.7 meters (150 feet) of such connection. Standpipe systems shall be installed in accordance with NFPA 14.

15.3.8. Fixed dry/wet chemical suppression systems are approved for protection of certain types of special occupancies, hazards and facilities, such as cooking surfaces, cooking exhaust systems, dip tanks and other operations involving flammable liquids. Dry chemical systems shall conform to NFPA 17 and wet chemical systems shall conform to NFPA 17A.

15.3.9. Other types of suppression systems include but are not limited to the following: High Expansion Foam system, Deluge system, water spray system and carbon dioxide systems.

15.4. PASSIVE FIRE PROTECTION SYSTEMS:

15.4.1. Public corridors must comply with NFPA 101. Corridors shall not be used as return air systems for air handling (supply, return or exhaust). Break areas, copy or fax office areas or other public gathering activity shall not be an integral part of any exit corridor. The function must be fully provided in a dedicated room or area, sized to accommodate the function and that is separated from the corridor by the appropriate fire rated separation. The function shall not use of the corridor as part of the function. Location of water coolers (recessed or semi recessed) in exit corridors is the only approved public use function.

15.4.2. The use of return air plenums (as opposed to return air duct systems) is strongly discouraged due to inherent problems with versatility and balancing of these systems. Plenums may however, be used as an integral part of an air handling system only if they conform to the requirements of NFPA 90A and 90B. Additionally, special justification for use of such systems shall be presented to ANG/CE for review and approval. Under no circumstances may combustible materials be located within the air plenum space. All electrical wiring passing through the space, including telephone and communication wiring, shall be approved for that type of environment or shall be in metal conduit. Insulation systems in the plenum environment shall be fully sealed from the air stream.

15.4.3. Provide fire dampers in accordance with NFPA 80, 90A and 90B. Fire dampers located in duct system shall be provided with access panels at both ceiling and in duct itself. Clearly identify locations and key to the posted operations instructions.

15.4.4. UL listed smoke and heat vents shall be provided in roofs of buildings containing materials having high heat-release potential, such as warehouses, flammable liquid storage and handling facilities, and other "extra hazard" occupancies. NFPA 204 provides guidance.

15.4.5. All penetrations of fire rated walls, partitions, shafts, floors and ceilings shall be fully detailed and fire-stopped by an approved/listed method.

15.4.6. Provide separate fire protection (FP-__) drawings in the plan sets. The minimum design fire protection drawing requirements for passive systems are as follows: On the fire protection plan sets, show all fire rated walls and partitions and indicated duration rating. Include full information on the location of all fire doors and fire damper devices for ducts. Include details indicating type and location of all access/egress corridors, etc. Provide life safety analysis for all paths of egress.

15.5. FIRE HYDRANTS:

15.5.1. All hydrants shall be installed adjacent to paved areas, not closer than 0.9 meters (3 feet) and not farther than 2.1 meters (7 feet) from the roadway shoulder or back of curb line, where they will be fully accessible to fire department apparatus. Hydrants shall be installed with not less than a 15.2 cm (6-inch) valved connection to the utility supply main. All hydrants shall be set at no less than 15.2 cm (6 inches) and no more than 30.5 cm (12 inches) from grade to bottom of flanged connection. Fire hydrant style shall be per the base standard. Fire hydrant color shall be as per NFPA 291, with the exception that the use of "tone-down" color is not permitted. This is due to ANG reliance on mutual aid fire protection for ANG facilities and the imperative need that hydrants must be readily recognizable by supporting fire stations. On Air Force and Reserve sites where the ANG is a tenant, follow host base style and color policy. Where hydrant flushing and flow testing would result in surface erosion, provide appropriately sized concrete splash block.

15.5.2. A sufficient number of hydrants shall be provided so that the hose stream demand can be met without more than 2839 liters (750 gallons) per minute from any single hydrant. Hydrants shall also be spaced in accordance with the following requirements:

15.5.2.1. All parts of buildings shall be reached by hose lays of not over 91.4 meters (300 feet) with consideration given to accessibility/obstructions.

15.5.2.2. Hydrants protecting warehouses shall be spaced a maximum of 121.9 meters (400 feet) apart.

15.5.2.3. Hydrants protecting aircraft hangars shall be located at 91.4 meters (300 feet) maximum intervals. There shall be at least one hydrant at each corner of the hangar.

15.5.2.4. Hydrants protecting POL storage and distribution facilities shall be spaced at 91.4 meters (300 feet) maximum intervals.

15.5.2.5. Hydrants shall be installed along all edges of aircraft parking and servicing aprons and shall be spaced at 91.4 meters (300 feet) maximum intervals. (Exception: exclude on specific edge, if placement conflicts with airport taxiway/runway criteria.) Top of hydrants shall not be higher than 61 cm (24 inches) above the ground level. Flush-type fire hydrants shall not be used.

15.6. HIGH EXPANSION FOAM HANGAR FIRE PROTECTION:

15.6.1. The HE components and sub systems shall be a separate unit from the building system and shall be factory built, UL approved "as built" for releasing agents. No field additions or modifications to the panel or system to make the system operate in the intended manner shall be allowed.

15.6.2. The HE panel shall have output signaling capability, which emulates the inputs on a zone by zone basis. The panel shall have a minimum of 48 hour maintenance free battery backup for operations.

15.6.3. The HE system when used in conjunction with a pre-action overhead sprinkler system, shall utilize cross-zoned, four wire, supervised heat detection configurations. Detectors shall be wired with a minimum of two zones with adjacent detectors on opposite zones. Detectors shall be of the rate compensated type with a temperature range of 102 - 112 degrees Centigrade (160 – 170 degrees Fahrenheit). (UL or FM listed). All wiring shall be in minimum 1.9 cm (3/4 inch) EMT or rigid conduit, depending on NEC requirement. When the HE system is used in conjunction with a wet pipe overhead sprinkler system, the cross-zoned detection system may be omitted.

15.6.4. The use of linear type wire or beam detection is not recommended.

15.6.7. HE systems shall include automatic trench drain closure. HE systems do not require independent containment systems. Reference AF ETL for further information. The automatic closure valve controller shall be of the type that must be manually reset. A key type switch or similar device, mounted exterior to the control panel shall control the bypass valve reset.

15.6.8. Provide separate fire protection (FP-__) drawings in the plan sets. The minimum design fire protection drawing requirements for HE systems are more detailed than that for other facility suppression systems. Minimum requirements are as follows: Provide occupancy hazard classification for each facility area. Show this information on a dedicated facility floor plan sheet and use a schedule and graphic symbols to differentiate between different classification areas. Provide the discharge density/calculation area per hazard classification on the classification schedule. Also provide the sub or total design area in square meters and feet. Show locations of all HE equipment. Indicate discharge and coverage requirements. Provide information on the fire protection sheets as to the size and location of incoming water supply, the point of connection to the base utility, location of individual sprinkler/standpipe riser(s), alarm valve riser diagram, fire department service connection, and location of all control valves and main drains. Provide flow data to be used in the hydraulic calculations (see paragraph in below) including flow in liters per minute (GPM), static and residual pressures and capacity/storage information. Fire protection sheets, shall include full design including plan view, elevations, sections and details of that particular system. Include full design and details of the fire protection room, fire pumps, HE equipment and piping, etc.. The sprinkler system contractor shall submit shop drawings.

15.6.9. As part of the design process, the A-E shall perform flow tests at a minimum of two nearby base locations to obtain accurate flow and pressure data to provide to the contractor. The A-E shall use this information to ascertain and design for water storage and fire pump requirements. The specifications shall also require that the contractor provide their own confirmation flow testing.

15.6.10. HE systems specifications shall include qualifications requirements outlined in paragraphs above. Specifications shall also clearly include an A-E developed full and detailed commissioning and start up plan that the contractor will follow. This plan will be comprehensive in nature and include personnel, equipment, procedures, checklists, required final report data and details of all results that are expected. A completed plan shall be detailed by the contractor and shall be reviewed as a submittal.

15.6.11. Design of the indicated suppression and HE systems and the specification of components shall comply with Air Force ETL 01-2 Fire Protection Engineering Criteria – New Aircraft Facilities, dated 1 April 2001 with additional information and requirements as contained in this Section.

15.6.12. Following are listed important component details that shall be designed into the Hangar suppression systems.

15.6.12.1. All sprinkler system piping shall be minimum schedule 40 steel. All couplings, fittings, etc. in a facility shall be of one manufacturer.

15.6.12.2. All sprinkler system piping shall be finish painted in both occupied and unoccupied spaces. Paint red above ceilings and in concealed spaces and provide flow direction identification. Paint in facility coordinated color in occupied and exterior spaces. If not painted red, provide systems identification, which also indicates direction of flow.

15.6.12.3. Installation of cleated (screw type) flanges on all piping is prohibited. Do not use victaulic type connections on the service side of facility alarm and isolation valve. Use only threaded or welded and flanged connections.

15.6.12.4. Service entrance piping shall be sleeved and sealed through the foundation and shall enter the HE/Pump room in a concrete pit. Service entrance pipe or any other portion of the fire protection system piping shall not be located under any portion of the facility ground floor. Thrust blocks shall be installed on underground piping at all changes in direction.

15.6.12.5. Provide dedicated fire service entrance with UL or FM listed back-flow prevention device. All fire service utility entrance shall be separate from facility domestic water supply utility entrance.

15.6.12.6. Sprinkler pendant placement shall be required to be carefully coordinated with all other trades. All heads shall be symmetrically placed. Provide architecturally coordinated trim rings, in occupied spaces.

15.6.12.7. Fire system exterior appurtenances shall be finished in either brass or factory finish red (Siamese, water gong, trim ring, etc.). Exterior piping and related components shall be painted to match adjacent facility finish.

15.6.12.8. Use of water powered gong is preferred.

15.6.12.9. All sprinkler piping shall be capable of being fully and completely drained for maintenance purposes. Main drains and end of line drains to facility exterior shall be provided. Drains shall have concrete splash block or similar method to control runoff and erosion at the facility exterior.

15.6.12.10. A test valve (inspectors test station) shall be installed at the end of each wet pipe system. This connection shall be piped from the end of the most remote branch line. This connection shall terminate outside the facility. Provide smooth bore stainless steel orifice giving a flow rate equivalent to one sprinkler head. Installation at the riser is not acceptable.

15.6.12.11. No fire protection piping shall be installed over the top or within 0.9 meters (3 feet) laterally of any electrical panels, disconnects, transformers or other electrical devices. Provide heavy gauge galvanized steel hoods and shields that are shop fabricated for electrical rooms and communications rooms to protect equipment from water spray where a sprinkler system is installed.

15.6.12.12. Fire protection piping support shall be directly from the facility structural system. No other equipment or materials may be supported from the fire protection support system. Do not hang from the underside of roofing deck or from other equipment or materials. All support systems shall include full lateral and horizontal bracing. The design documents shall fully detail the support systems. Special attention shall be placed on the support systems for pre-action cannon and overhead systems. Design of support shall as a minimum, comply with seismic criteria as outlined in NFPA 13.

15.6.12.13. All system valves shall have tamper switches provided.

15.6.12.14. Emergency eyewash and shower stations shall be connected to the fire alarm system and shall report as a separate zone. These stations shall report as fire (or medical emergency if possible) and not as a trouble alarm.

15.6.12.15. All wall and floor penetrations with fire protection piping shall be fully sleeved and sealed. Sleeve shall be schedule 40 steel and protrude minimum of 10.2 cm (4 inches) on either side of wall surface with trim ring. Proper penetration detail and sealant shall be specified for penetrations of rated walls and floors.

15.6.12.16. Galvanized piping, fittings or devices are prohibited for used on all systems related to the HE or sprinkler systems. Consideration must be given for the removal of pumps and valves for maintenance.

15.6.12.17. HE piping shall be schedule 40 steel or FRP materials only. All connections shall be either of threaded or flanged and bolted connection. Piping design shall show consideration for the removal of pumps, valves and other items for maintenance.

15.6.12.18. Bollards (concrete filled, steel, set in floor) shall be placed around all fire protection equipment that is floor mounted.

15.6.13. The fire pump system and necessary components of an HE system shall be located in a separate, dedicated fire protection room with large, double doors exiting only to the exterior of the facility. The room floor plan shall be sufficiently sized for the installation, observation, testing and maintenance of all associated equipment. Entry and exit shall be made without climbing over any piping or equipment, and adequate spacing shall be provided so any pumps, valves and similar devices may be removed/replaced without disassembling other portions of the system. Locate all equipment on concrete house maintenance pads with chamfer edge. Provide floor drains in fire protection room. Typical finish for this room will be to have painted exposed structure above, block filled and painted, sound insulated CMU walls and concrete floor with sealer applied.

15.7. FIRE SYSTEM APPURTENANCES:

15.7.1. Fire protection design for all facilities shall include the following listed features and items.

15.7.2 Provide Knox (or equivalent type) boxes, located on the exterior of each main building entry where the annunciator is internally located. The box shall be cast brass, recessed style and suitable for housing appropriate keys. Box shall be wired to a tamper switch and routed through the fire alarm panel.

15.7.3 Provide fire extinguisher cabinets throughout all facilities as per NFPA 10 and as coordinated with the ANG base fire chief. Locate an extinguisher at each facility exit door. Locate extinguishers at both interior and exterior facility locations. All extinguisher cabinets shall be recessed or semi-recessed style with eased corner and glass face. Cabinets shall be specified to be of heavy duty brushed stainless steel construction. Cabinets shall be specified to accommodate the size extinguishers that will be provided by the base fire department. Extinguishers are Government Furnished (GF) items.

15.7.4. Provide red light emitting diode (LED) emergency exit lighting at locations conforming to code.

15.7.5. Provide emergency ballast packs in standard lighting system. Wall packs and self-illuminating systems for emergency lighting shall not be used.

15.7.6. Fire system exterior appurtenances shall be finished in either brass or factory finish red (Siamese, water gong, trim ring, etc.). Exterior piping and related components shall be painted to match adjacent facility finish.

15.8. SYSTEMS IDENTIFICATION:

15.8.1. Specifications shall completely outline requirements for identification systems and operation information for all fire detection and protection systems. Identification systems shall include complete labeling, graphics, painting, color selection of components, tags, signs, placards and other forms of necessary identification.

15.8.2. All equipment identification and operations signage shall be engraved on metal or plastic material and mechanically attached to the facility.

15.8.3. All identification and operations identifications shall be coordinated with and keyed to the posted operations instructions and the O&M manuals.

15.9. OPERATIONS AND MAINTENANCE MANUALS:

15.9.1. Specifications shall be very comprehensive regarding requirements for Fire Protection Systems Operations and Maintenance Manuals. Manuals shall be required to include original data on all materials, systems, components, equipment and warranties provided. Manuals shall include approved shop drawings and other as-built information. Manuals shall be professionally prepared, including printed spine and cover with full table of contents and tabbed indexing. Full size sheets, as required, shall be folded into special holding pockets. All manual data shall be required to be original copy. Faxed, hand written or illegible material is not acceptable. Typically, manuals should be prepared in three ring binders for ease of document addition or removal.

15.9.2. O&M manuals shall be required to be completed, submitted and approved by no later than at the 75% construction complete stage. Three copies of final manuals are required. One copy is for file, one copy is for fire department training and the other copy will be located in the O&M manual lock box, located in each mechanical room.

15.9.3. Manuals will be required to include, but not be limited to:

- Include full instructions on servicing and maintenance requirements.
- Include operating instructions including start up, emergency shut down and start up, seasonal servicing and start up, etc.
- Include owner's manuals for each item of equipment.

- Include all equipment wiring diagrams
- Include all piping and wiring systems diagrams and operational diagrams
- Include full parts lists and exploded schematic diagrams
- Include full warranty information
- Include all available manufacturer installation and O&M manuals
- Include full names, addresses, phone numbers, suppliers, service companies, contract numbers and other points of contact/information relative to the job.

15.9.4. Specifications shall also require that three copies of original manufacturer operations, service and training manuals shall be provided for all fire protection equipment or systems provided. Examples of these types of manuals would include factory manuals for fire pumps, HE equipment and fire alarm control panels.

15.10. POSTED OPERATIONS INSTRUCTIONS:

15.10.1. Specifications shall be very comprehensive concerning the requirements for fire protection systems Posted Operations Instructions. Posted instructions shall be required to be completed with professionally prepared graphics, printed on full size sheets and shall be in color. Instructions shall be prepared for all fire protection systems and shall include all components.

15.10.2. Posted instructions will include (but not be limited to) the following:

- Comprehensive schematics for Sprinkler - HE distributing systems
- Facility floor plans showing location of all fire equipment and devices with coordinated identification. Show items such as fire walls, fire dampers etc.
- System diagrams, including isometrics of special equipment and systems (fire alarm riser, fire pumps, HE system, etc.)
- Valve charts
- Equipment schedule
- Wiring diagrams and schematics

15.10.3. Posted Operations Instructions shall be framed in heavy gauge extruded metal frames, mounted under glass and shall be water/weather proof. Instructions will be permanently mounted in the reserved clear wall area (show reserved area in the design drawing details) in each fire protection room or mechanical room.

15.11. FIRE DETECTION AND SUPPRESSION COMMISSIONING AND ACCEPTANCE:

15.11.1. Specifications shall be very thorough concerning the requirements for and commissioning and acceptance procedures for all detection and suppression systems. Of particular importance are the commissioning requirements for Hangar detection and suppression systems.

15.11.2. Commissioning requirements, checklists, tool and parts requirements, manufacturer involvement, etc. shall be comprehensive and based on standards such as NFPA, standard of the industry or manufacturer practice. Commissioning and acceptance procedures and checklists shall be part of the acceptance procedure for any facility and shall be required as a submission by the contractor. Commissioning and checklist documentation shall be completed by the contractor, as part of the pre-final acceptance of the facility. Checklists shall be submitted prior to substantial completion inspections.

15.12. TRAINING:

15.12.1. Specifications shall be very thorough concerning requirements for training of personnel on all fire detection and suppression systems. A complete mix of on-site, classroom and/or off-site training shall be specified for all equipment and systems. Level and quantity of training shall depend on complexity of the system. Training shall be specified to be complete with all materials, fees and tuition covered by the contract. (only employee travel costs shall not be covered by the contract) Training shall be provided by factory instructors or factory trained and authorized instructors. Specify clearly the number of hours of training and the number of personnel to be trained. Clearly indicate what systems and components are to have training on.

15.13. FIRE DETECTION/SUPPRESSION CRITERIA FOR SPECIFIC FACILITIES:

15.13.1. The following section describes current minimum requirements and criteria for ANG facility fire protection systems. These minimum requirements are necessary to obtain uniform application of fire protection engineering throughout the ANG and to highlight problem areas encountered with various facilities. Special or more stringent requirements not covered by this section shall be referred to ANG/CE for guidance/resolution.

15.13.2. Where economically feasible, common practice, possible from an engineering capability perspective, a requirement of local area code or host base policy, it is recommended minimum policy be exceeded and that full facility automatic suppression systems be provided for all facility types.

15.13.3. Deviation from the minimum criteria, where a valid need exists and where an alternate solution involving equivalent concept and sound fire protection engineering is available, may be considered. Any deviation from minimum criteria must have written approval from ANG/CE. The request for deviation approval must include justification, hazard analysis, cost comparison, criteria used and other pertinent data. Should approval be granted, it shall apply only to the specific request under consideration and not to cases with similar circumstances. Lack of funds shall not be considered sufficient justification for deviation below established ANG minimum fire protection standards.

FACILITY FIRE DETECTION AND PROTECTION REQUIREMENTS TABLE

ITEM	FUNCTION	CODES	REMARKS
1.	Above Ground Storage Magazine	A	May be part of Item 23.
2.	Aerial Port Training	A	
3.	Aeromedical Evacuation Training	A	
4.	Aircraft Engine Inspection and Maintenance Shop	A	See Item 55b.
5.	Aircraft Fuel System Maintenance and Corrosion Control Hangar	A, C, E, F, G	High Expansion Foam with overhead wetpipe. See Items 55f and 55g.
6.	Aircraft General Purpose Maintenance Shop(s)	A, C	Provide Code C even if constructed separately from Hangar facility. See Item 55d.
7.	Aircraft Maintenance Hangar	A, C, E, F, G	High Expansion Foam with overhead wetpipe.
8.	Aircraft Organizational Maintenance Shop(s)	A, C	Provide Code C even if constructed separately from Hangar facility.
9.	Aircraft Shelter (Alert)	A	Provide overhead heat detectors (rate compensated)
10.	Aircraft Shelter (Weather)	A	Provide overhead heat detectors (rate compensated)
11.	Aerospace Support Equipment Shop and Storage (ASE)	A	See Items 55a, 55f and 55g.
12.	Avionics	A, B, D	Provide Code B in Vault only. See Item 55h. Provide Code D in Shops and Storage areas only.
13.	Base Civil Engineering Maintenance	A	Code B also applies if providing Mobility Storage. (Storage area only)
14.	Base Civil Engineering Storage	A	Code B also applies if providing Mobility Storage. (Storage area only)

ITEM	FUNCTION	CODES	REMARKS
15.	Base Hazardous Materials Storage	A, B, I	All acids, batteries (primary and secondary), compressed gasses, flammable liquids, combustible liquids, hazardous materials and wastes, etc..
16.	Audiovisual Services Center	A	
17.	Base Supply and Equipment Storage	A	Code B also applies if providing Mobility Storage. (Storage area only)
18.	Base Supply and Equipment Warehouse	A, B	Provide Code B in Supply Warehouse and in Vault. Note: Vault also has separate IDS system. See Item 55h. Provide one hour minimum rated fire wall(s) between Warehouse and Shop / Administrative areas of facility.
19.	Communications	A, D	Provide Code D for computer room(s) and communications room(s). (Electronic equipment rooms)
20.	Communications and Electronics Training	A, D	Provide Code D for Shop(s) and for Storage room(s) only.
21.	POL Operations	A	
21a.	POL Lab	A	Chemical suppression system for Lab stainless steel exhaust hood.
21b.	POL Pumphouse	A, B	Provide Code B only if Pumphouse is completely enclosed.
22.	Squadron Operations	A, B	Provide Code B in Vault area only. See Item 55h. Note: Vault also has separate IDS system.
22a.	Base Operations	A	
22b.	Command Post	A	

ITEM	FUNCTION	CODES	REMARKS
23.	Conventional Munitions Shop	A, B	Provide Code B in Paint Bay only. See Items 55f and 55g.
24.	Dining Hall	A	Provide chemical suppression for kitchen hoods and exhaust systems. Interface with FACP as separate zones.
25.	Disaster Preparedness	A	Normally part of Item 13.
26.	Dormitories and Living Quarters	A, B, Z	Provide Code A as a minimum. Provide Code B if two stories (or more) in height or more than 464.5 SM (5,000 SF), per floor.
27.	ECM Pod Shop and Storage	A, D	Normally part of Item 12.
28.	Fire Crash/Rescue Station	A, B, Z	See Item 26 for Living/Sleeping Quarters requirements. Provide Code B for Apparatus Bay.
29.	Flight Simulator Training	A, D	Simulator equipment may have self-contained systems. Code D must still be provided for spaces serving Simulator and Equipment.
30.	Hydrant Fueling System	X	See also Item(s) 21.
31.	Hydrazine (Special Fuels) Storage and Servicing	A, B	Provide Code B if on Active duty or Reserve Site. Also provide if part of a Code B protected facility.
32.	Igloo Storage	A	
33.	Jet Fuel Operating and Storage Systems (Bulk storage tanks)	A, J	
34.	LANA Pod Shop and Storage	A, D	Normally part of Item 12.
35.	LANTIRN Pod Shop and Storage	A, D	Normally part of Item 12.
36.	Liquid Oxygen and Nitrogen (LOX/LIN) Storage	A	
37.	Medical Training and Administration	A	
38.	Mobility Equipment Storage	A, B	Provide Code B requirement in all facilities or locations where Mobility Equipment is stored.

ITEM	FUNCTION	CODES	REMARKS
39.	Munitions Loading Crew Training	A, C, E, F, G	High Expansion Foam. Overhead wet pipe sprinkler system.
40.	Nondestructive Inspection (NDI) Shop	A	
41.	Power Check Pad with Suppressor	A, H	Provide Code H in T-9 Type units only.
42.	Readiness Crew (Alert)	A, Z	See Item 26.
43.	Refueling Vehicle Parking	X	
44.	Refueling Vehicle Shop	A, B	Normally part of Item 52. Do not provide direct access to adjacent facility interior.
45.	Operational Training (O&T)	A	
46.	Security Forces Operations (Includes CATM and CATS)	A, B	Provide Code B in Vault area only. See Item 55h. Note: Vault also has separate IDS system
47.	Small Arm Range Facility	A	
48.	Survival Equipment Shop	A	
49.	Troop Camp (Quarters)	A	Provide Smoke Detectors as a minimum.
50.	Truck Jet Fuel Fill Stand(s)	X	Emergency Eyewash Station shall be tied into FACP.
51.	Vehicle Fueling Station	X	Emergency Eyewash Station shall be tied into FACP.
52.	Vehicle Maintenance	A	See Item 44 and 55a, 55f, and 55g.
53.	Vehicle Operations Covered Parking	A, B	Provide Code B for facilities that service 10 or more vehicles. Consider Code D as alternative depending on local climate.
54.	Weapons and Release Systems Shop	A	
55.	Special Rooms and Areas		
55a.	Battery Room	A	See Items 10 and 52
55b.	Bearing Inspection Room	A	See Item 4. Provide positive room pressure.

ITEM	FUNCTION	CODES	REMARKS
55c.	Combustion Engine Rooms (Emergency Generator, Diesel Fire Pumps, Etc.)	A, B	Code B is not required when part of an occupied facility that does not have Code B requirements and when the room is separated from the remainder of the facility by a minimum four (4) hour rated fire wall.
55d.	Composite Repair Shop	A, B	See Item 6.
	Mechanical Room(s). Boiler Room, Air Handler Room, Chiller Room, etc.	A, B	Code B is not required when part of an occupied facility that does not have Code B requirements. Provide sound insulated masonry walls with minimum two (2) hour fire rating. Provide exterior exit to room only. Provide two exits if room exceeds 46.5 SM (500 SF) floor area or if fuel fired equipment is larger than 400,000 BTU/HR Input rated.
55f.	Paint Spray Room or Booth	A, B	See Items 5, 10, 23 and 52.
55g.	Paint Storage (Interior)	A, I	Normally part of Item 15.
55h.	Vaults (Security class A and B). Secure Storage Rooms	A, D	Provide Code D in Vault area only. See Items 12, 18, 22 and 46. Note: Vault also has separate IDS system

CODE	CODE DESCRIPTION
A	Provide complete facility fire detection systems. Provide heat and smoke detectors wired through a Fire Alarm Control Panel (FACP) and transmit to two locations (Base Central System and Security Forces or Command Post). Provide manual alarm stations at all egress points from each facility. Provide facility with local audio and visual alarms (interior and exterior). To avoid conflict with furniture and systems workstations, locate audio and visual alarm devices on ceiling or mount high on walls. Provide for portable extinguishers throughout. See requirements found in Section 15.2. Automatic Detection and Notification Systems.
B	Provide wet pipe suppression system. Fire alarm shall be wired through a Fire Alarm Control Panel (FACP) and transmitted to two locations (Base Central System and Security Forces or Command Post). Provide manual alarm stations at all egress points from each facility. Provide facility with local audio and visual alarms (interior and exterior). Provide for portable extinguishers throughout. Density and capacity designed in accordance with hazard classification. See requirements found in Section 15.3. Automatic Suppression Systems.
C	Provide wet pipe suppression system. Provide system throughout all areas (other than hangar bay) of any facility which has a HE suppression system installed. Fire alarm shall be wired through a Fire Alarm Control Panel (FACP) and transmitted to two locations (Base Central System and Security Forces or Command Post). Provide manual alarm stations at all egress points from each facility. Provide facility with local audio and visual alarms (interior and exterior). Provide for portable extinguishers throughout. Also provide a one (1) hour (minimum) fire rated separation wall between the aircraft bay and any adjacent area. Aircraft bays that house different functions but are adjacent to each other also require a one hour (minimum) fire rated separation wall. Density and capacity of systems shall be designed in accordance with hazard classification. See requirements found in Section 15.3. Automatic Suppression Systems.

D Provide pre-action (dry) suppression system. Provide system throughout all areas associated with specific facility function. Pre-action system shall include automatic shut-off of all appropriate electrical system(s). This shall include but not be limited to systems such as bench power, simulator systems power, computer systems, etc.. Fire alarm shall be wired through a Fire Alarm Control Panel (FACP) and transmitted to two locations (Base Central System and Security Forces or Command Post). Provide manual alarm stations at all egress points from each facility. Provide facility with local audio and visual alarms (interior and exterior). Provide for portable extinguishers throughout. Density and capacity shall be designed in accordance with hazard classification. See requirements found in Section 15.3. Automatic Suppression Systems.

E Provide High Expansion Foam suppression system. Activation of HE systems shall be by manual release and flow indication from overhead suppression or by manual release and cross zone heat detection systems. Other release scenarios are as indicated in AF ETL. Releasing panel shall report to facility Fire Alarm Control Panel (FACP). Facility fire alarm shall be wired through a Fire Alarm Control Panel (FACP) and transmitted to two locations (Base Central System and Security Forces or Command Post). Provide manual alarm stations at all egress points from each facility. Provide facility with local audio and visual alarms (interior and exterior). Audio and visual alarm shall differentiate between an HE activation alarm and a general facility system activation alarm. Provide for portable extinguishers throughout. Provide emergency power source for automatic door closure. These systems and features are required for all new and for all modified or renovated facilities. Follow requirements of AF ETL 01-2 Fire Protection Engineering Criteria - New Aircraft Facilities, with ANG amendments contained herein. Retention systems are not required for HE systems. Provide for automatic closure of hangar trench drain in the event of system alarm or discharge.

F Provide hangar high bay suppression systems. Provide wet pipe sprinkler system or pre-action (dry) overhead sprinkler system with rate-compensated cross-zone heat detectors in hangar high bay. Activation of high bay system shall automatically activate HE systems. Facility fire alarm shall be wired through a Fire Alarm Control Panel (FACP) and transmitted to two locations (Base Central System and Security Forces or Command Post). Provide manual alarm stations at all egress points from each facility. Provide facility with local audio and visual alarms (interior and exterior). Audio and visual alarm shall differentiate between an HE activation alarm and a general facility system activation alarm. Provide for portable extinguishers throughout. These systems and features are required for all new and for all modified or renovated facilities. Follow requirements of AF ETL 01-2 Fire Protection Engineering Criteria - New Aircraft Facilities, with ANG amendments contained herein. Retention systems are not required for HE systems. Provide for automatic closure of hangar trench drain in the event of system alarm or discharge

Note: Heat detector spacing in hangar bay shall be maximum of 7.6 meters (25 feet).

G Do not provide retention systems for HE system release. See AF ETL 01-2.

H Provide water source only Deluge system.

I Sprinkler discharge shall be captured by floor drain system and piped through cast iron pipe to concrete retention/detention basin(s). Underground steel tank(s) may be used if justification is provided to and approval obtained from ANG/CE.

J Provide distribution system of foam to POL tank space. Provide pumper truck connection for water supply or foam supply.

X Follow the appropriate NFPA Standard.

Z Provide combination heat/smoke detectors and carbon monoxide detectors in all living and sleeping areas.

SECTION 16 ELECTRICAL REQUIREMENTS

16.1. POWER SYSTEMS:

16.1.1. Transformers shall generally be 3-phase with a delta-connected primary and grounded wye-connected secondary. Panels shall be 3 phase, 4 wire. Determination should be made through the base civil engineer as to dual primary voltage requirements for service transformers. (Some bases are programmed to have their primary distribution voltages upgraded.)

16.1.1.1. Provide base utility service master metering, metering for all facilities and all major points of use (airfield lighting, site lighting, wash racks, etc.). Coordinate meter locations with the BCE. Tie metering into base EMCS system when possible.

16.1.2. Load calculations shall be provided to verify size and adequacy of distribution systems. Identify connected load, demand factor and demand load for all panels and transformers. The following demand factors shall be used unless other criteria are provided and approved:

16.1.2.1. Lighting and computer systems - 1.00

16.1.2.2. HVAC - 0.70

16.1.2.3. Shop equipment - 0.50

16.1.2.4. Convenience outlets - 0.25

16.1.3. Distribution, Power and Control Wiring. The minimum size conductor for power and lighting circuits shall be No. 12 AWG. Control circuits shall use No. 14 AWG size conductors minimum. All utility and facility wiring and all conductors shall be copper. Busses and lugs in panels and disconnects shall be copper construction also.

16.1.4. Some facilities require the derivation of different systems other than just voltage transformation; e.g., 400 HZ distribution or direct current systems (28 VDC). The conversion device shall be contractor furnished, contractor installed. Unless the unit is existing, the 400 HZ conversion device shall be a solid state converter rather than a motor generator unit. Due to additional heat generated in ferrous conduit at higher frequencies, 400 HZ circuits shall be distributed in aluminum conduit within buildings and PVC outside. Derating calculations may be necessary for wiring, buses, etc.

16.1.5. Most facilities have certain essential loads. These loads must be kept energized for safety, security or resource conservation reasons. These generally include egress lighting, minimal heating, communications, security systems, fire detection, alarm, and suppression systems, emergency exhaust and control systems, sump pumps. etc.

These loads shall be fed from a separate panel through a manual transfer switch via normal and emergency sources. The emergency source is usually Government furnished and installed. The generator plug, grounding, disconnect switch and concrete pad (all sized to mate with the GFE temporary generator) shall be provided as part of facility construction.

16.1.6. Fixed Generators with Auto Start & Transfer. Fixed generators with automatic start and transfer capabilities are authorized for the following locations:

a. Alert mission circuits
b. Prime Fire-Crash Rescue (Fire Station – critical circuits only)
c. Prime Airfield Lighting (Airfield Lighting/NAVAIDS/Control Towers)
d. Regional Operation Support Centers (ROSC) (serve ROSC equipment, HVAC and lighting systems only)
e. Aircraft Hangars where HE foam systems are installed (to close doors only)

16.1.7. Power Conditioning and un-interruptible Power Supplies (UPS). Where required due to the sensitive nature of connected equipment (e.g., mainframe computer systems), special conditioning and UPS systems shall be purchased with equipment funds as part of the user's equipment contract.

16.1.8. For personal computers (PCs) throughout each facility, the A-E shall provide a dedicated power circuit with isolated grounding conductor and dedicated outlets at the PC locations. In general each room shall have a minimum of two PC outlets on opposing walls and general office space shall have PC outlets provided every 10 feet on center. The PC outlet shall have an isolated ground (IG) with surge protection (Hubbell Surge/IG receptacle or equal). The PC outlet cover shall be specifically identified by color and graphic as to that outlets function.

16.1.9. Utility distribution shall be through conduit (minimum 10.2 cm (4-inch)) underground service. Provide an abundance of spare 10.2 cm (4-inch) conduit(s) to main utility manholes for each facility and provide abundant spare conduits between co-located or composite facility construction. An example of this would be a BCE facility with a separate Shops and Storage buildings.

16.1.10. Architecturally coordinate placement of all exterior facility and site electrical service items and lighting systems and supports. Transformers and switch gear shall be located in appropriate accessible locations but as unobtrusively as possible. These items shall also be screened with facility matching architectural screen walls and concealed with landscaping. All exterior facility electrical components such as but not limited to transformers, switch gear, disconnects, motor control centers, conduit and piping, etc. shall be located in screened courtyards or utility rooms and shall be finished in colors that are architecturally compatible with the facility and consistent with the base color palate.

16.1.11. Design for and require contractor coordination of placement of all electrical components with other trades. In no circumstance shall water piping (domestic, HVAC, etc.) be run over top of or within 0.9 meters (3 feet) laterally from electrical panels, transformers, switches, disconnects or similar devices. Use of drip pans as an alternative is not acceptable practice.

16.1.12. To the greatest extent possible, standardize all lighting systems and devices in each facility and base wide. Standardization shall include manufacturer, type of lamp used, color of devices and style of fixtures. For new facilities, coordinate with the BCE as to what standard lighting systems have been provided for other newly constructed facilities.

16.1.13. Lighting.

16.1.13.1. Interior lighting shall generally be fluorescent 0.6 meter by 1.2 meter (2 foot by 4 foot) T-8 lamps with nominal wattage of 32 watts and minimum average lamp efficacy of 75.0. Lamp style shall generally be open faced with architectural grill and parabolic reflectors. 0.6 meter by 0.6 meter (2 foot by 2 foot) T-8 lamp lighting may be used for some applications based on room requirements or architecture. Ballast's shall be the fully electronic type. Lenses shall be open-faced with parabolic reflector behind lamps. Each room or workspace greater than 41.8 square meters (450 square feet) continuous shall be switched separately. Each office space greater than 9.3 square meters (100 square feet) continuous shall have as a minimum, dual switching enabling occupants to lower lighting levels by half. Fixtures that utilize the "U" tube lighting shall not be used, except where absolutely necessary.

16.1.13.2. Emergency lighting shall be accomplished by inverter battery packs located in the fluorescent light fixtures to provide illumination of egress paths in areas where fluorescent lighting is used. Emergency exit lighting shall be of the LED type, with the LED's forming the letters. Use of radioluminesant, fluorescent or incandescent exit lighting is not permitted.

16.1.13.3. Provide photocells, timers and interconnection to base EMCS to control exterior facility and site lighting systems. Provide motion sensor lighting systems in restrooms, locker rooms and other areas where energy savings are possible without causing safety concerns.

16.1.13.4. Zone building lighting systems such that areas that are typically not used during non-UTA drill, that are able to operate on reduced lighting levels or that are appropriately day lighted, can be isolated and turned off.

16.1.13.5. Metal halide lighting shall generally be used for shops and maintenance and hangar areas. One in four metal halide fixtures shall include auxiliary quartz lamps for "instant on" and "re-strike" capability and shall include 90-minute battery backup.

16.1.13.6. Exterior Lighting. Exterior facility lighting shall be accomplished through the use of wall mounted and soffit mounted light fixtures. Standardize the types of fixtures provided in each facility. Also, attempt to standardize the fixture types used for all base facilities to the fullest extent possible. Lighting levels shall be as indicated. Consider applications of solar powered exterior lighting.

16.1.13.7. Exterior Site Lighting. Provide base standard site lighting. Generally, provide round concrete light base with mortar wash and chamfer edge. Light bases in landscape areas shall extend a minimum of 15.2 cm (6 inches) above grade and a maximum of 0.3 meters (1 foot) above grade. Light bases provided in parking lots and other pavements areas shall generally be not less than 0.9 meters (3 feet) in height. Light poles and fixtures shall be standard throughout the base (style, heights, colors, etc.) and shall achieve the lighting levels as indicated in this section. Light pole heights may differ for various functions, (storage yards, parking lots, roadways, POL, Apron, entrance, pedestrian pathways, etc.) but shall be standard for all similar functions on the base. Locate light bases a minimum of 1.2 meters (4 feet) from back of curb in all possible locations. Site lighting shall not be fed from facility circuits but shall have dedicated utility infrastructure. Provide metering and monitoring as well as energy conservation capabilities. Consider applications of solar powered area lighting.

16.1.13.8. Apron Lighting. Provide base standardized apron lighting to achieve required light levels as indicated in this section. Apron lighting shall be pole mounted systems and shall not be affixed to flight line facilities. Provide round concrete light base with mortar wash and chamfer edge. Light bases shall extend a minimum of 15.2 cm (6 inches) above final finish grade. Lighting pole and light fixtures shall be finished in coordinated and base compatible architectural color. Apron lighting shall be controlled from a minimum of two locations (security forces/command post and flight line operations). Apron lighting circuits shall be designed for maximum flexibility so that each apron light pole and/or certain lights on each pole can be independently operated. This provides flexibility in apron operations and allow for energy conservation.

16.2. ENERGY EFFICIENCY AND CONSERVATION: Requirements for efficiency and conservation shall comply with Section 11 of this ETL, ENERGY CONSERVATION CRITERIA. Design shall comply with ANG ETL 93-1, "Energy Conservation Criteria." For lighting, include energy efficient ballast's, lamps, and reflectors.

16.3. CATHODIC PROTECTION:

16.3.1. Provide cathodic protection wherever underground metallic structures (tanks and associated piping) will be used. Cathodic protection surveys and design shall be in accordance with:

16.3.1.1. MIL-HDBK 1004/10, "Electrical Engineering Cathodic Protection."

16.3.1.2. National Association of Corrosion Engineers (NACE) Standards RP0169, "Control of External Corrosion on Underground or Submerged Metallic Piping Systems."

16.3.1.3. RP0285, "Control of External Corrosion on Metallic Buried, Partially Buried, or Submerged Liquid Storage Systems."

16.3.2. Surveys, Field Tests and Design. Survey and design must be performed by a NACE-accredited Corrosion Specialist or a registered professional Corrosion Engineer. This accreditation and/or registration must have been obtained in the field of cathodic protection. Design shall be complete. A performance specification is not acceptable. Design shall include a statement in the specifications that any change in system layout or acceptable test values must first be approved by the Contracting Officer, with the assistance of the BCE.

16.3.2.1. The design of all cathodic protection systems shall include the installation of sufficient test stations to perform routine tests, surveys and troubleshooting.

16.3.2.2. Specifications shall require that the contractor shall complete the initial system start-up and survey and to complete and certify all results. These results shall be submitted along with system test equipment, training and O&M manuals to the BCE. The contractor that performs the installation, testing and certification shall be NACE certified and shall provide proof of such as a submittal.

16.3.3. Buried or Submerged Metallic Structures and Piping:

16.3.3.1. The following shall be coated and cathodically protected regardless of the levels of soil resistivity, hydrogen ion activity, water table, etc.:

Natural Gas
Oxygen
Chilled Water Piping (Mission Essential)
Ductile or Cast Iron Pressurized Piping Under a Floor
Gravity Sewer Lines (If Cost Effective. Provide Analysis)
Liquid Fuels
Underground Storage Tanks
Fire Suppression/Protection
Other Product Systems Identified by ANG/CE

16.3.3.2. The following shall have cathodic protection if the soil resistivity at the project site is below 10,000 ohms/cm:

Other Buried and/or Submerged Metallic Utility Not Covered Above
Potable Water Piping
Forced Sanitary Sewer Piping
Chilled Water Piping (Non-Mission Essential)
Concentric Neutral Cables

16.3.3.3. Cathodically protected oil-water separators shall be electrically isolated from all metallic conduits and piping, and shall have a minimum of one cathodic protection test station and two (2) structure wires.

16.3.4. Ductile or Cast Iron Pipes. If soil resistivity is below 10,000 ohms/cm, provide cathodic protection, protective coating and bond joints. If soil resistivity is 10,000 ohms/cm or above, provide bond joints. Provide test stations at each location and clearly demonstrate this element in the design documents.

16.3.5. Aboveground Metal Tanks:

16.3.5.1. Vertical aboveground jet fuel storage tanks require cathodic protection (impressed current).

16.3.5.2. Water storage tanks shall be cathodically protected on the inside, and, if in contact with the earth, shall also be cathodically protected on the exterior.

16.3.6. Environmental Compliance. All tank and associated piping designs and installations shall be in compliance with federal, state and local environmental requirements.

16.3.7. All cathodic protection systems shall include the installation of a sufficient number of test stations to perform routine tests, surveys and troubleshooting.

16.3.8. Specifications shall require that the contractor shall complete the initial survey, and complete and certify all results. These results shall be submitted along with system test equipment, training and O&M manuals to the BCE. The contractor that performs the installation, testing and certification shall be NACE certified and shall provide proof of such as a submittal.

16.4. LIGHTNING PROTECTION: Design shall be based on NFPA 780. Lightning protection shall be provided for all buildings higher than 15.2 meters (50 feet) with a risk assessment of moderate or high as outlined in Appendix I of NFPA 780, and for the following locations: Munitions facilities, Weapons storage vaults, Alert aircraft hangars, Fuel cell and Corrosion Control hangars and Refueler Maintenance bay hangar facilities. Lightning protection system shall not degrade the roofing system integrity. Lightning protection system conductor and air terminals shall be of copper. The specifications shall clearly demonstrate that the contractor is not to use the facility structure as a down conductor or to use any portion of the structure as a conductor, except as necessary to protect the structure itself. All lightning protection system installations must be certified by UL or by L.P.I (Lightning Protection Institute). Copies of the certification shall be placed in the O&M manuals.

16.5. SPECIAL SYSTEMS AND COMMUNICATIONS: These systems shall include telephone/intercom, computer/data, public address, closed circuit television, fire suppression/alarm, security, etc. Verify all requirements with Base Communications Officer, Visual Information Manager, Base Fire Chief, and Security Officer, as appropriate, through the Base Civil Engineer. Telecommunications cabling systems are installed using a Total Network Concept supporting a multi-product, multi-vendor environment. The common thread among all installed equipment is performance specifications and interoperability. All components of telecommunications system such as cabling, patch panels, patch panel cables, connectors, modular jacks, etc., and shall be rated with the same level of performance specifications. The minimum grade of cable and termination hardware to be used within buildings is Category 5 (Cat 5) unshielded twisted pair (UTP). The user will provide additional performance specifications, if required. Optical fiber may be used as deemed financially feasible. All telecommunications must be tested according to the below listed standards. Test results shall be provided to the Base Civil Engineer and Base Contracting Officer prior to system acceptance.

16.5.1. Compliance with the following standards is mandatory and applies to all telecommunications installations.

16.5.1.1. TIA/EIA-568-A, Commercial Building Telecommunications Cabling Standard, including attachments and addendum's.

16.5.1.2. EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces

16.5.1.3. TIA/EIA-606, Administration Standard for the Telecommunications Infrastructure of Communications Buildings

16.5.1.4. EIA/TIA-607, Commercial Building Grounding/Bonding Requirements

16.5.2. Exterior System - All Systems. Contractor's shall provide a complete exterior raceway (see note below) system of 10.2 cm (4 inches) minimum diameter, hand holes/man holes, associated communication cables, splices, and terminations, from the base service connection point to the main telephone terminal board in the building. It is required that the main terminal communications room for facility be located in the building footprint as indicated elsewhere in this section. (If the existing base distribution is direct burial, extend the existing system into the building. Route new cables in a 10.2 cm (4 inch) conduit from 1.5 meters (5 feet) out from the building to the main telephone terminal board.) For new construction, provide 10.2 cm (4 inch) conduit system and avoid direct burial. Provide abundant spare/reserve 10.2 cm (4 inch) conduits for all systems between base infrastructure and facility. Also provide an abundance of spare 10.2 cm (4 inch) conduits between co-located or composite facility construction. An example of this would be a BCE facility with separate Shops and Storage building.

Note: For RPM projects, communication cable (e.g. Telephone, Data, PA, CCTV, Fiber Optics, Etc.) shall be purchased through ANG/C4 using communication funds.

16.5.3. Interior Systems - All Systems:

16.5.3.1. Contractors shall be required to provide a complete cable (see note below) system for all security, all communication systems and all fire alarm systems, except as identified below. Contractors shall provide a complete raceway system of minimum 1.9 cm (3/4 inch) rigid conduit from outlet box to terminal board/control panel), outlet boxes, device plates and dedicated power circuits/receptacles. Raceway systems shall be separate and dedicated for each separate system (Fire, Security, Telephone, PA, CCTV, Fiber Optic, Etc.). Stubbing raceways only into ceiling space is not acceptable practice. Cable trays of the centrally hung, two side loading type shall be utilized in all facility systems, except for fire and security systems. Cable tray design and layout shall allow cable tray system to only be located over corridors. Distance that cable may be run from cable tray until entering raceway shall not exceed three feet. Plenum rated cables shall be used in cable trays. Fire detection and alarm systems as well as all security systems, may not be mixed with other communications systems nor routed in facility cable tray systems. Fire detection and alarm systems shall be installed in separate dedicated metal raceway (rigid conduit) complete from device to FACP. Security systems shall be provided in separate dedicated metal raceway (rigid conduit) complete.

Note: For RPM projects, communication cable (e.g. Telephone, Data, PA, CCTV, Fiber Optics, etc.) shall be purchased through ANG/C4 using communication funds.

16.5.3.2. Raceway Identification. Communication system type (e.g., Telephone, PA, CCTV, Data, Fiber Optics, Fire alarm, IDS, etc.) shall be clearly identified on the raceway by frequent color-coding and labels. Identification shall be at 3.1 meter (10 foot) maximum spacing and at every change in direction and wall penetration. Coordinate identification with the Base Civil Engineer. Each system shall be clearly identified with engraved plastic or metal labels fastened to each device, junction box, pull box, terminal and panel. Coordinate identification systems with the posted operations instructions and O& M manuals.

16.5.3.3. Government shall provide all communications instrumentation and equipment unless otherwise indicated. IDS and fire detection systems shall be provided turn-key complete by the contractor.

16.5.3.4. All cabling will be tested per Bell Standard 43401 upon installation.

16.5.4. Voice/Data/Imagery Systems:

16.5.4.1. Provide all of the following features at the main telephone terminal board at each communication room. Provide B grade or better ¾ inch painted plywood backboard mounted with a 10.2 cm (4 inch) stand off (this is to dress the cables behind the backboard). Backboard shall run from the ceiling to the floor. Provide AT&T 110 type (or as requested by user) termination blocks will be used. A dedicated ground wire (MIL STD-188) from building signal ground to plywood back board shall be provided. Also provide dedicated power circuits/receptacles with a minimum of 20 AMP rating. Main communications utility terminal board room will be controlled via lock and key or cipher lock.

16.5.4.2. Work area cabling (see note below) and termination is critical to a well-managed distribution system. Provide a minimum of two telecommunications outlets with four, modular-type jacks (two RJ-45 and two RJ-11) per office, conference room, or training area; on opposing walls. In addition, in large admin areas where the length of walls between corners exceeds 4.6 meters (15 feet), provide additional outlets so that the maximum separation between outlets does not exceed 3.1 meters (10 feet). Each four-pair cable shall be terminated in an eight-position modular jack. The Base Communications Officer must select the eight-position jack pin/pair assignment – T568: A or B (circle one). Specify, identify, and label all cables, jacks and patch panels, including all spare conductors.

Note: For RPM projects, communication cable (e.g. telephone, data, PA, CCTV etc.) shall be purchased through ANG/C4 using communication funds.

16.5.4.3. When concrete slab floors are used, install under-floor ducts, multi-channel raceway, trench-duct systems, or floor-to-ceiling columns in large areas (such as conference and training rooms, amphitheaters, or any other large rooms) to support connectivity. Establish an outlet density of one outlet per every 9.3 square meters (100 square feet) of work area. Extend ducts or raceways into any adjoining audio/visual support rooms.

16.5.4.4. External raceway or wire molding shall be used only as a last resort and with the permission of the Base Communication Officer. No exposed wires shall be permitted in any work area under any circumstances. Completed cabling fill rates will not exceed 30% of the total capacity of any conduit, duct, tray, or raceway.

16.5.4.5. Provide cable with minimum 30% vacant pairs after system installation from main telephone terminal board (exterior/copper distribution) to telephone closets

16.5.4.6. Provide a dedicated telephone outlet in all mechanical, electrical, communication and distribution frame rooms

16.5.5. Computer Cable System.

16.5.5.1. All interior data shall be a minimum of CAT 5 UTP cable (see note below). Fiber cable can be used as deemed financially feasible. All CAT 5 cable and connecting hardware shall have transmission parameters characterized to a minimum of 100 MHz and meet Telecommunications Industry Association/Electronic Industries Association (TIA/EIA) 568 (A or B) or Institute of Electrical and Electronic Engineers (IEEE) standards. Performance testing will meet these standards and a hard copy testing submittal shall be required to be provided to the contracting officer prior to pre-final inspections.

Note: For RPM projects, communication cable (e.g. telephone, data, PA, CCTV etc.) shall be purchased through ANG/C4 using communication funds.

16.5.5.2. Category 5 cables shall be terminated in facility telecommunications closets to a Category 5 UTP 110 patch panel that is mounted in a standard 48.3 cm (19 inch) rack. All racks shall be of sturdy manufacturer extruded aluminum construction. Provide finish in black or gray powder coat. Racks shall be 198.1 cm to 213.4 cm (78 to 84 inches) in height and shall be securely bolted to the floor.

16.5.6. Public Address System. Provide associated transformers, power supplies, interface equipment, speakers, speaker grills and volume controls. Transformer impedance shall match that of the amplifier. PA amplifier and microphone shall be Government provided. Wiring (18 gauge S-R Insulated) shall be specified as tinned copper, S-R PVC insulated, conductors cabled with aluminum-polyester shield and 20 AWG stranded tinned copper drain wire (Trade number 9418).

16.5.7. Closed Circuit Television System. Contractor shall provide taps, splitter and amplifiers as required as part of cable (see note below) system. Cable shall be coaxial RG 59/U (Trade number 8241).

Note: For RPM projects, communication cable (e.g. telephone, data, PA, CCTV etc.) shall be purchased through ANG/SC using communication funds.

16.5.8. Fire Suppression/Alarm System:

16.5.8.1. The contractor shall provide complete system including instrumentation and equipment. Wiring shall be a 4-wire (Class A) supervised system. Supply conductors shall be in a separate conduit from return conductors.

16.5.8.2. Raceway system shall be minimum 1.9 cm (3/4/ inch) rigid metallic conduit, complete and separate from device to FACP. Refer to Section 15 of this document for additional guidance.

16.5.8.3. A radio controlled fire alarm reporting system is recommended. System must be supported on narrow band frequencies only.

16.5.9. Security Systems:

16.5.9.1. Information Security. Classified information and equipment shall be stored in accordance with DoD 5200.1-R, "Information Security Program". For storage of TOP SECRET information and equipment, the area shall be designed as a Secure Storage Room with IDS.

16.5.9.2 Classified Discussions. Classified discussion areas shall be designed in accordance with AFP 88-26, "Construction of Secure Conference Rooms".

16.5.9.3 "TEMPEST" requirements shall be applied to the Telecommunications/Data Automation Area (only where classified information is being processed, I.E., active crypto). TEMPEST design shall be in accordance with AFR 56-16, "Control of Compromising Emanations", NACSIM 5203 & 5204 "Guidelines for Facility Design and Red/black Installation", and AFP 88-26 "Construction of Secure Conference Rooms". Grounding shall be in accordance with MIL-HDBK 419 and MIL-STD 188-124A. In the coding/decoding area, TEMPEST requirements include metallic breaks in perimeter walls, man-barriers, and sound baffles. Verify requirement with ANG/C4 for TEMPEST filters for telephone, fire alarm, and security intrusion detection system (power filter is no longer required). TEMPEST shielding is not required.

16.5.9.4. Intrusion Detection Security System (IDS). The provided design shall be in accordance with DoD 5200.1-R, "Information Security Program" and shall include all security program requirements.

16.5.9.4.1. System Equipment. The contractor shall provide a complete (turn-key) IDS system including instrumentation and equipment. System equipment shall not be Joint-Services Interior Intrusion Detection System equipment (J-SIIDS), but shall be equipment that is commercially available and locally maintained that meets or exceeds J-SIIDS requirements.

16.5.9.4.2. System Layout. Wiring shall be a 4-wire supervised system. Locate the IDS control panel (and all IDS control switches) in the alarmed area, and the annunciator panel at the security forces 24-hour duty station. Secondary alarm capability may be provided to alarm at the command post. Provide an authorized entry phone at the entry to the alarmed area. The first level of IDS shall be infrared motion detection. The second level, if required (I.E. small arms storage, Category I & II munitions), shall be door/window contacts and vibration sensors on all walls and ceiling (and floor, if not reinforced concrete floor located at grade). Provide a duress button in small arms vaults and munitions storage facilities, which alarm at the security forces 24-hour duty station and at the base command post.

16.5.9.4.3. Raceway system shall be minimum 1.9 cm (3/4 inch) rigid EMT conduit, continuous, complete and separate from all other systems.

16.5.9.4.4. Cable system shall include cable from control panel to telephone closet.

16.5.10. Information Transfer Nodes (ITN's)

16.5.10.1. ITN's shall be designed as large Telecommunications Equipment Rooms. An ITN serves as the collection point for all inter-building fiber within a particular zone of a Base and is directly connected with two distinct routes on the base fiber optic cable backbone. All other facilities in each designated base zone are serviced from the ITN in that zone. ANG bases normally will have no more than four ITN's. The ITN room must be located within 15.2 meters (50 feet) of the outside plant cable entrance per the National Electric Code but should be as centrally located within a facility as possible. In facilities where ITN's are provided, this space shall also serve as the telecommunication room for that building. The number and location of base ITN's are determined by the base STEM and documented in the base Communications and Information Systems blueprint.

16.5.10.1.1. Minimum space requirement for an ITN room shall be 10.2 square meters (110 square feet).

16.5.11. Telecommunications Room (TR's)

16.5.11.1. All ANG facilities shall have dedicated telecommunications room(s). All TR's must be located within 15.2 meters (50 feet) of outside plant cable entrance per the National Electric Code. The number of TR's to be provided for each facility shall be determined by the amount of square foot area served. Normally, provide one TR for every 929 square meters (10,000 square feet) of facility area served.

16.5.11.2. General space requirement for TR development shall be approximately 0.069 square meters (0.75 square feet) of TR equipment room floor space for every 9.29 square meters (100 square feet) of user workstation area within the facility.

16.5.11.3. Typical ITN and TR room requirements. Provide B grade or better 1.9 cm (3/4 inch), primed and painted plywood backboard mounted with a 10.2 cm (4 inch) stand off (this is to dress the cables behind the backboard). Backboard will run from the ceiling to the floor or to a minimum height of 2.4 meters to 3.7 meters (eight to twelve feet). Where practical, do not provide ceilings in ITN or TR rooms but rather provide painted exposed structure. In no case shall insulation systems be exposed to the ITN or TR space. Provide dedicated power circuits/receptacles with a minimum of 20 AMP rating. Room access shall be controlled via lock and key or cipher lock. Provide VCT flooring and painted walls and ceiling areas. Lighting shall be per the lighting intensity table contained herein. Provide independent ventilation systems and dedicated temperature control system capability.

16.6. HAZARDOUS ZONES: Hazardous zones are identified and classified in NFPA 70 (NEC). Most of the areas encountered in ANG facilities are as identified below. (Note: "AFF" is above finished floor.)

16.6.1. General. For all locations NFPA 70, OSHA and AFOSH requirements shall be met. Where possible, mount equipment and wiring to avoid hazardous locations and use standard devices and wiring. Identify the classification and limits of each hazardous zone on the drawings.

16.6.2. Hazardous Zone Classification Table:

HAZARDOUS ZONE CLASSIFICATION				
LOCATION	CLASSIFICATION			NOTES
	NON HAZARDOUS	CLASS I DIVISION I	CLASS I DIVISION II	
Battery Room	X			2
Bladder Maintenance Room	X			3,9
Blue Foam Storage Room (C130)			X	9
Carpenter Shop	X			9,11
Composite Materials Repair (Fiberglass)	X			9,11
Drop Tank Maintenance Room	X			3,9
Flammable Liquids Storage Room			X	14
Fuel Hydrant Pits		X		
Hangar - Maintenance, Alert and Load Crew		Floor Pits	X	4,5,13
Hangar - Weapons Calibration		Floor Pits	X	4,5,13
Hangar - Fuel Cell Maintenance		Floor Pits	X	4,5,6,13
Hazardous Storage Building			X	10
Hush House			X	4,5
Hydrazine Facility (Service)		X		9
Hydrazine Facility (Storage)			X	9
LOX Maintenance Shop	X			
LOX Storage Facility			X	7
Packing and Crating	X			9,11
Paint Spray Room		X		12
POL Lab			Below 48”AFF	3,9,16
POL Pump house - POL System		X		8,9
Refueler Maintenance Bay		Floor Pits	X	1,3,6,15
Refueler Vehicle Parking Structure			X	1
Solvent Rooms (within 5 feet of tank)			X	NEC Art 516
Vehicle/Automotive Maintenance		Floor Pits	Below18"AFF	17
Welding Area(s)	X			9

NOTES:

1. Classification area shall be from below height of overhead door, or below 1.5 meters (5 feet) above refueler vehicle, whichever is highest. The entire area within 1.5 meters (5 feet) (all directions) of the parked refueler vehicle and up to 0.9 meters (3 feet) above finish floor, shall be classified as Class I, Division II.. Areas beyond 1.5 meters (5 feet) (all directions) of the parked refueler vehicle and above 0.9 meters (3 feet) from finish floor are not part of the Class I, Division II classification area. Wherever possible, do not locate electrical distribution or utilization equipment in zones classified as hazardous.
2. Interconnect charger with room exhaust fan. (Provide explosion proof fan with non-spark blades. Ventilate vertically to the extent possible. Exhaust duct shall be welded stainless steel and shall be hermetically sealed. Exhaust duct shall be under negative pressure to the maximum extent possible (draw through rather than blow through)).
3. All electrical equipment, outlets, conduit and wiring shall be located within 61 cm (24 inches) of walls and a minimum of 122 cm (48-inches) above finish floor.
4. Classification area shall be in accordance with NEC Article 513 – Aircraft Hangars.
5. Locate all electrical elements within the Hangar bay zone within 61 cm (24 inches) of walls and above 122 cm (48-inches) above finish floor. Justification for mounting locations outside of this parameter shall be only when no other cost effective or feasible location can be identified. Wherever possible, do not locate electrical distribution or utilization equipment in zones classified as hazardous.
6. Interconnect pit/trench vapor/liquid detector with the trench exhaust fan and base EMCS system. (Provide explosion proof fan with non-spark blades. Ventilate vertically to the extent possible. Exhaust duct shall be welded stainless steel and shall be hermetically sealed. Exhaust duct shall be under negative pressure to the maximum extent possible (draw through rather than blow through)).
7. Classification area shall be up to 2.4 meters (8 feet) above grade.
8. Areas classified in accordance with current Air Force standards or American Petroleum Institute (API) requirements, whichever are more stringent.
9. Provide segregated area with exhaust system at laboratory hood. (Provide explosion proof fan with non-spark blades. Ventilate vertically to the extent possible. Exhaust duct shall be welded stainless steel and be hermetically sealed. Exhaust duct shall be under negative pressure to the maximum extent possible (draw through rather than blow through)).
10. Locate facility separately (detached) from main facility.
11. Provide dust tight fixtures.
12. Do not provide interior doors leading into hangar bay.
13. Reference NEC Article 513 – Aircraft Hangars. All adjacent and communicating areas not suitably cut off from the hangar bay and within 7.6 linear meters (25 feet) of travel distance from the hangar bay, shall be classified as Class I, Division II up to a level of 45.7 cm (18 inches) above the hangar bay floor. Wherever possible, do not locate electrical distribution or utilization equipment in zones classified as hazardous.

14. Flammable liquids shall be stored inside the building in approved containers or in grounded metal cabinets, up to the maximum amount identified in NFPA 30.
15. Do not provide doors leading to adjacent interior spaces. Provide exit doors (minimum 2) leading directly to the outside.
16. The entire area within 1.5 meters (5 feet) (all directions) of the laboratory exhaust hood shall be classified as Class I, Division 1.
17. To the greatest extent possible, locate all electrical elements above the hazardous classification zone.

16.7. LIGHTING SYSTEMS AND INTENSITIES:

16.7.1. The Illuminating Engineering Society (IES) recommended minimum lighting intensities are to be considered as maximum design levels and shall not be significantly exceeded. IES lighting intensities are the illuminations required for specific visual tasks and may be provided by the general illumination in the area combined with supplementary illumination for the particular task. The IES recommended intensities are not necessarily to be considered as general illumination intensities for specific areas. The intensity of the general illumination for any area shall not exceed 75 foot-candles maintained. All devices shall use energy efficient ballast's, lamps, and reflectors.

16.7.2. Task/area illumination can also be identified in terms of unit power density (UPD) in units of watts/square feet (W/SF). This indication of illumination level in terms of power density is based on treating a specific task or task area with adequate illumination using available energy-efficient lighting. While the W/SF indicated are intended to relate directly to specific visual task requirements, it is desirable that the combination of general and supplementary illumination does not exceed the values shown.

16.7.3. Exterior lighting, other than at building entrances, is usually provided by building mounted fixtures sized for 1/2 foot-candle at 4.6 meters (15 feet) from building. Exceptions require specific authorization by ANG/CE.

16.7.3.1. Facility entrances shall be illuminated as appropriate to the specific facility function. Lighting fixture type and style shall be appropriate to the architecture and type of facility. Generally, primary facility entrances shall be illuminated to not less than 15 foot-candle at 4.6 meters (15 feet) from the entry door and secondary entrances shall be illuminated to not less than 10 foot-candle at 4.6 meters (15 feet).

16.7.3.2. Industrial facilities and other facilities which have roll up doors for facility function shall have exterior lighting provided at the roll up door. Illumination shall be with wall pack style light fixture providing 15 foot-candles at 4.6 meters (15 feet) from the door.

16.7.3.3. Facility exterior mechanical, electrical and communications courtyards shall have exterior lighting provided. Illumination shall be with wall pack style light fixture providing 15 foot-candles at 4.6 meters (15 feet) from the mechanical room door.

16.7.4. The following section describes current minimum requirements and criteria for ANG facility lighting systems. These minimum requirements are necessary to obtain uniform application of lighting systems throughout the ANG and to highlight problem areas encountered with various facilities. Special or more stringent requirements not covered by this section shall be referred to ANG/CE for guidance/resolution.

16.7.5. Deviation from the minimum criteria, where a valid need exists and where an alternate solution involving equivalent concept and sound engineering is available, may be considered. Any deviation from minimum criteria must have written approval from ANG/CE. The request for deviation approval must include justification, analysis, cost comparison, criteria used and other pertinent data. Should approval be granted, it shall apply only to the specific request under consideration and not to cases with similar circumstances.

Selected Functional Area Description	Maintained General Illumination Level Design Foot-candles	Unit Power Density. (Task/Area) W/SF
Administrative Office		
Work Stations	50 (See note 1)	2.2
Work Areas	30 (See note 1)	2.0
Non-working Areas	10	0.5
Accounting Room	75	4.7
Aircraft Parking Ramp	0.5 (See note 2)	---
Auditorium	20/50 (See note 3)	1.0/2.2
Bathroom	20	1.0
Breakroom	20	1.0
Cafeteria	25	1.4
Classroom		
Work Stations	50 (See note 1)	2.2
Work Areas	20/50 (See note 3)	1.0/2.2
Non-working Areas	10	0.5
Communications Utility Room	20	0.5
Computer Facility		
Computer Equipment Room or CRT Space	50	2.2
Computer Work Area	50	2.2
Conference Room	25/75 (See note 3)	1.5/2.5
Corridors/Circulation Spaces	10/20 (See note 4)	1.0
Dormitory		
Sleeping Area	2	0.5
Activity Area	15	0.5
Drafting Room	75	3.2
Electrical Utility Room	20	0.5
Elevator Equipment Room	20	0.5
Emergency Generator Room	20	0.5
Engine Overhaul Shop	50	2.5
Exit	1 (See note 5)	---
Facility Exterior Lighting (Primary Entrances)	15	0.5
Facility Exterior Lighting (Secondary Entrances)	10	0.5
Facility Exterior Lighting (other than at entrances)	0.5	---
Fixed Communications Facilities		
Battery Room	50	2.2
Electronic Equipment Room	70	3.2
Selected Functional	**Maintained General**	**Unit Power Density.**

Area Description	Illumination Level Design Foot-candles	(Task/Area) W/SF
Crypto Room	70	3.5
Electronic Equipment Maintenance Room	70	3.5
Garage Parking Area	5	0.5
Garage Entrance	30	1.5
Garage Service Area	50	2.5
Hangar (High Bay Area)	30 (See note 6)	2.5
Janitor Closet	15	0.5
Kitchen (General)	50	2.5
Kitchen (Food preparation areas only)	70	3.5
Lobby (Main Facility Entrance)	20 (See note 7)	1.0
Lobby (Secondary Entrances)	20	1.0
Locker Room and Shower	20	0.5
Lounge	20	0.5
Mail Room	50	2.5
Mechanical Room(s)	20	1.0
Munitions Compound	2.0 (See note 8)	---
Office Space		
General Open Administrative Space	50 (See note 1)	2.5
Individual Office Space	50 (See note 1)	2.2
Paint Spray Room	50	2.5
Parking Lot	1.0	---
POL Compound	1.0/5.0 (See note 9)	--/0.5
Roads	0.5	---
Roads (Main Intersections)	1.0	---
Roads (Base entrance Gate House area only)	5.0	0.5
Roll Up Doors (Shops, Warehouses, Etc.)	15 (See note 10)	0.5
Shops		
Carpenter Shop	30	1.3
Engine Shop	50	2.0
Sheet Metal Shop	30	1.3
Machine Shop	50	1.8
Paint Shop	50	2.5
Vehicle/ASE Maintenance Shops	50	2.0
Welding Shop	30	1.3
Selected Functional Area Description	**Maintained General Illumination Level**	**Unit Power Density. (Task/Area)**

	Design Foot-candles	W/SF
Steps (Interior)	15	0.5
Steps (Exterior)	5	---
Storage Room	15	0.5
Storage Compounds (BCE, Logistics, Squadron Storage, Communications, Fuel pods, etc.)	1.0	---
Switchgear Room	20	0.5
Training Room	20/50 (See note 3)	1.0/2.2
Transformer Vault	20	0.5
Vault	20	0.5
Utility Room	15	0.5
Warehouse		
Active Warehouse	10	0.5
Active Bulk Storage	10	0.5
Bin Storage	5	0.5
Inactive Storage Rack	5	0.5
Mechanical Material Handling	10	0.5
Accumulation Conveyor Line	10	0.5
Control Center	30	1.5
Control Station	30	1.5
Loading and Unloading Area	20	1.0
Main Aisles	15	0.5
Loading Dock	20	1.0

Note 1. Provide specific task lighting or capability for task lighting at workstations/work areas to minimum 50 foot-candles. In no case shall the overall combined lighting level be maintained at above 75 foot-candles.

Note 2. Airfield 0.5 F.C. is at furthermost part of aircraft parking position from lighting.

Note 3. Multiple function lighting including fluorescent general task lighting and separate dimmable incandescent down-lighting for presentations.

Note 4. Provide dual switching for multi-level corridor lighting. Alternate fixture units on each circuit.

Note 5. Provide red light LED style emergency exit signage.

Note 6. Provide wall mounted specific task lighting based on specific airframe and floor parking plan. Task lighting shall be to maximum 50 foot-candles. Coordinate with user for locations.

Note 7. Provide multiple function lighting including fluorescent general lobby lighting and separate (energy-efficient) dimmable incandescent down-lighting for highlighting walls displays and artwork.

Note 8. Provide 2.0 foot-candles at munitions gated entrance only. Provide 1.0 foot-candles for the remainder of the munitions fenced compound.

Note 9. General site illumination to 1.0 foot-candle. Provide 5.0 foot-candle illumination at Government and Commercial loading and unloading stations, HHTCS, Pump House and other high activity areas as necessary.

Note 10. (Exterior Lighting) Provide 15 FC lighting at and above exterior of roll up door.

SECTION 17 SAFETY

17.1. INTRODUCTION:

17.1.1. Listed below are major safety features required in ANG facility design and construction. This list is not intended to be all inclusive and facility design and construction must comply with all OSHA, AFOSH, and NFPA requirements.

17.1.2. References listed are from:

1. Occupational, Safety, and Health Administration (OSHA)
   29 Code of Federal Regulation (CFR) 1910.XXX (General Industry)
2. Air Force Occupational Safety and Health Standards (AFOSH Standards)
3. National Electrical Codes (NEC)
4. National Fire Protection Association (NFPA)
5. American National Standards Institute (ANSI)
6. Air Force Manuals (AFMAN)
7. Air Force Pamphlets (AFPAM)
8. Air Force Instructions (AFI)
9. Department of Defense Instructions (DoDI)

17.2. SAFETY FEATURES IN FACILITY DESIGN: Listed below are major references for requirements of safety features in all ANG facility design. This listing does not encompass all Bio-Environmental, Industrial Hygiene, Public Health, and Fire Protection references.

ANSI A10.2-44	Safety Code For Building Construction
ANSI A12.1-67	Safety Requirements for Floor and Wall Openings
ANSI B31-5-68	Fuel Gas Piping
ANSI C1-71	National Electric Code
ANSI Z9.2-60	Fundamentals Governing the Design and Operation of Local Exhaust Systems
ANSI Z33.1-61	Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying
ANSI Z21.30-64	Requirements for Gas Appliances and Gas Piping Installation
ANSI Z54.1-63	Safety Standard for Non-Medical X-Ray and Sealed Gamma Ray Sources
NFPA 54-1969	Standard for the Installation of Gas Appliances and Gas Piping
NFPA 70-1971	National Electric Code
NFPA 80-1970	Standard for the Installation of Fire Doors and Windows
NFPA 101-1970	Code for Life Safety From Fire in Buildings and Structures

Item	Reference
1. Fall Protection - Fall Protection requirements when working at heights of 3.1 meters (10 feet) or more above ground level.	1910.66 AFOSH 91-100
2. Emergency Eyewash/Showers - Provide in areas where personnel could be contaminated. Tempered water supply, lockable isolation ball valve with audio and visual alarm.	1910.94 1910.151 AFOSH 91-32
3. Hazardous Zones, Classified Locations, Electrical - Requirements for electric equipment, wiring in locations which are classified dependent on flammable and combustible properties. NEC 513- Aircraft, 514-Service Stations, 515-Bulk Storage, 516-Spray Applications, 517-General.	NEC 500 Series 1910.307 1910.399 DoDI 4145.19R1
4. Flammable Storage - Classification criteria for flammable and combustible materials, description of proper storage methods.	1910.106 AFOSH 91-43 DoDI 4145.19R1
5. Clear Zones (POL, Hush House, Hydrazine, LOX/LIN, compressed gasses, fuels etc.). - Minimum required distances for the above.	AFOSH 91-38 1910.104 1910.110(b) DoDI 4145 R19.1
6. Building Separation (Explosives, Munitions Quantity/Distance (QD) - Minimum acceptable storage requirements for munitions/explosives.	AFMAN 91-201 DoD STD 6055.9 NFPA 68-1954
7. Building Set Back Distance to Aircraft Parking Apron.	AFR 86-14
8. Airfield Clear Zones.	FAA Regs AFR 86-14
9. Building Separation (General) - 127-100 specifies 15.2 meter (50 foot) clear zone for hangars, combustible/flammable storage criteria.	AFOSH 91-100 1910.104
10. Egress Lighting - Fundamental requirements essential to providing a safe means of egress. Egress Lighting shall be battery backup, integral to the lay in ceiling lighting fixture.	1910.36 1910.37 NFPA 101 Sec 5
11. Number of Exits/Exit Path Length/Dead End Corridors - The minimum number of separate exits, exit access and discharge of exits.	1910.36 1910.37 NFPA 101 Sec 5
12. Exit Signs with Emergency Power Supply - Internally illuminated LED exit sign shall be provided.	1910.36 1910.37 NFPA 101, Sec 5

Item	Reference
13. Marked Aisles - Permanent aisles and passageways shall be appropriately marked.	1910.22 AFOSH 91-22 NFPA 101, Sec 5
14. Dust Collection Systems - Requirements for exhaust systems.	1910.94 AFOSH 48-2 ANSI Z9.2-60
15. Fume Hoods/Special Ventilation - Requirements for ventilation when working with dusts, fumes, gases, vapors, dirt, etc.	1910.94 1910.107 1910.108 1910.252 AFOSH 48-2 ANSI Z9.2-60 ANSI Z33.1-66
16. Breathing Air System for Painting Applications - The air for respirators shall be free from harmful quantities of dusts, mists, noxious-gases and shall be oil free.	1910.134 AFOSH 91-100
17. Vehicle Exhaust Systems (Vehicle Maintenance & Fire Station Apparatus Bays, ASE and Support Equipment) - Required where vehicles will be operated in garages, shops or other enclosed areas for the purposes of maintenance.	AFOSH 48-2 1910.94 ANSI Z9.2 ANSI Z33.1 NFPA 1500, Section 7-1.6.
18. Battery Charger Circuits Interconnected to Exhaust System - Ventilate battery rooms to prevent the accumulation of gases.	1910.178 AFOSH 91-66
19. Fire Extinguishers - Selection, placement, inspection, accessibility, and availability of portable fire extinguishers. Type identified in project book. Location is identified by AE. Extinguisher is Government furnished.	1910.157 AFOSH 91-56 NFPA 10
20. Fire Suppression/ Systems - Selection, design requirements for automatic sprinkler, fixed extinguisher and fire detection systems. For older stand pipe and hose systems, refer to 1910.158	1910.159 through 163 NFPA 101, Sec 7-6 AFOSH 91-56
21. Fire Detection, Alarm - Applies to all automatic fire detection systems and to all emergency employee alarm systems.	1910.164 1910.165 AFOSH 91-56
22. Fire Walls/Fire Doors/Fire Dampers.	NFPA 101 AFOSH 91-56
23. Personnel Static Grounding - Static ground, buss bars, and conductive floors. This requirement protects personnel from electrical shock hazard.	AFI 32-1065 NFPA 77

Item	Reference
24. Aircraft Grounding permanent/temporary - Pertains to aircraft static grounds.	TO 00-25-172
25. Equipment Grounding - Equipment grounding involves interconnecting and connecting to earth all non current-carrying metal parts of an electrical wiring system and equipment connected to the system.	AFI 32-1065 AFOSH 91-20 AFOSH 91-12 AFOSH 91-8
26. Non-Static Floor Systems - Facilities requiring Electro-static Discharge (ESD) protection. Refer to job specific manuals and T.O.'s.	AFI 32-1065
27. Lightning Protection - Must comply with Electrical Design Lightning and Static Electricity Protection.	AFI 32-1065 AFI 91-201 T.O. 00-25-172 1910.109 1910.300 series DoD STD 6055.9 NFPA 780, 78
28. Ground Fault Protection - Sets requirements for GFCI. (GFCI - Ground Fault Circuit Interrupter Protection)	1910.303 1910.304 NEC 250 NFPA 514 ANSI C1-71 NFPA 70-1971
29. Electrical Equipment Service, LO/TO, Low Voltage Dropout - Shop equipment must be manually restarted upon lose of power. (LO/TO - Lockout/Tagout). All equipment must have lockable service disconnect within equipment space and line of sight of equipment.	1910.213 1910.147 AFOSH 91-45 T.O. 34-1-3
30. Hangar Door Opening/Closing Alarm/Operation - Powered Hanger door design requirements.	AFOSH 91-100 chapter 7
31. Glass Breakage and Personnel Risk Assessment (Explosives Clear Zones) - Reference Message R162015Z May 96 ANG/SE	AFMAN 91-201 DoDI 6055.9 paragraph 4B.2
32. Aircraft Power Cables on/in Floor - Aisles and passageways shall be kept clear and in good repair, with no obstructions across or in aisles that could create a hazard.	1910.22 1910.307 1910.399
33. Access Ladders/Safety Cages - Requirements for access ladders and requirements for safety cages on all ladders.	1910.27 AFOSH 91-22
34. Fixed Industrial Stairs (Above Ground Storage Tanks, Mezzanines, Etc.) - Stairway and ramp design considerations.	AFOSH 91-22 1910.24

Item	Reference
35. Process Fluids/Holding Tanks (Acids, Photo Development, Etc.)	AFOSH 91-119 1910.119
36. X-Ray Lead lining/Safety Lights - Minimum requirements for protection of personnel	1910.96 NEC 475 UL 187 NFPA 54-1969
37. Hoists/Cranes - Design specification, and acquisition requirements.	1910.144 1910.179 AFOSH 91-46
38. Compressed Air Regulators - Compressed air used for cleaning shall be reduced to 87.8 kgs per cm squared (30 P.S.I.)	1910.242 AFOSH 91-100
39. Work Surfaces dry and slip resistant (Slip Resistant Floors) – Painted floors shall have slip resistant medium grit surface. The floor of every workroom shall be kept clean and so far as possible, a dry condition.	1910.22 AFOSH 91-22

REFERENCE GUIDE
FOR
SAFETY FEATURES IN FACILITY DESIGN

Title	Reference
	OSHA 29 CFR
GENERAL REQUIREMENTS	1910.22
FIXED INDUSTRIAL STAIRS	1910.24
MEANS OF EGRESS - DEFINITIONS	1910.36
MEANS OF EGRESS - GENERAL	1910.37
POWERED PLATFORMS FOR BUILDING MAINTENANCE	1910.66
VENTILATION	1910.94
IONIZING RADIATION	1910.96
OXYGEN	1910.104
FLAMMABLE & COMBUSTIBLE LIQUIDS	1910.106
SPRAY FINISHING USING FLAMMABLE & COMBUSTIBLE MATERIALS	1910.107
DIP TANKS CONTAINING FLAMMABLE AND COMBUSTIBLE LIQUIDS	1910.108
STORAGE AND HANDLING OF LIQUEFIED PETROLEUM GASES	1910.110
PROCESS SAFETY MANAGEMENT OF HIGHLY HAZARDOUS CHEMICALS	1910.119
RESPIRATORY PROTECTION	1910.134
SAFETY COLOR CODE FOR MARKING PHYSICAL HAZARDS	1910.144
CONTROL OF HAZARDOUS ENERGY	1910.147
MEDICAL SERVICES AND FIRST AID	1910.151
PORTABLE FIRE EXTINGUISHERS	1910.157
AUTOMATIC SPRINKLER SYSTEMS	1910.159
FIXED EXTINGUISHING SYSTEMS - GENERAL	1910.160
FIXED EXTINGUISHING SYSTEMS - DRY CHEMICAL	1910.161
FIXED EXTINGUISHING SYSTEMS - GASEOUS AGENT	1910.162
FIXED EXTINGUISHING SYSTEMS - WATER SPRAY & FOAM	1910.163
FIRE DETECTION SYSTEMS	1910.164
EMPLOYEE ALARM SYSTEMS	1910.165
POWERED INDUSTRIAL TRUCKS	1910.178
OVERHEAD AND GANTRY CRANES	1910.179
WOODWORKING MACHINERY REQUIREMENTS	1910.213
HAND AND PORTABLE POWER TOOLS & EQUIPMENT - GENERAL	1910.242
GENERAL REQUIREMENTS (MACHINERY)	1910.252
GENERAL REQUIREMENTS - ELECTRICAL	1910.303
WIRING DESIGN AND PROTECTION	1910.304
GROUND FAULT CIRCUIT INTERRUPTERS FOR WATER FOUNTAINS	1910.306
HAZARDOUS (CLASSIFIED) LOCATIONS	1910.307
SPECIAL SYSTEMS	1910.308
DEFINITIONS TO THE 300 SUBPART	1910.399

Title	Reference
	AFOSH
INDUSTRIAL VENTILATION	48-2
HYDROCARBON FUELS	91-38
GENERAL INDUSTRIAL OPERATIONS	91-66
CIVIL ENGINEERING	91-10
MACHINERY	91-12
VEHICLE MAINTENANCE SHOPS	91-20
WALKING SURFACES, GUARDING WALL & FLOOR OPENINGS & HOLES, FIXED INDUSTRIAL STAIRS AND PORTABLE AND FIXED LADDERS	91-22
EMERGENCY SHOWERS & EYEWASH UNITS	91-32
FLAMMABLE AND COMBUSTIBLE LIQUIDS	91-43
HAZARDOUS ENERGY CONTROL & MISHAP PREVENTION SIGNS & TAGS	91-45
MATERIAL HANDLING & STORAGE EQUIPMENT	91-46
FIRE PROTECTION AND PREVENTION	91-56
AIRCRAFT FLIGHTLINE - GROUND OPERATION & ACTIVITIES	91-100
PROCESS SAFETY MANAGEMENT	91-119
NOTE: Prior to using any of the above AFOSH standards	
cross-check with the AFIND 17 to assure that only	
current standards and requirements are being	
utilized.	
For the OSHA 29 CFR references check the latest	
editions of the OSHA OCIS or CD-ROM	
available at the local base Safety Office.	

SECTION 18 ENVIRONMENTAL REQUIRMENTS AND REFERENCES

18.1. REQUIREMENTS: The A-E shall be responsible for providing designs that conform to all applicable Federal, State and Local environmental codes and requirements.

18.2. HAZARDOUS MATERIAL USAGE:

18.2.1. The A-E shall edit and include as required for the installation, the attached Hazardous Material Usage Requirements in Division 1 of project specifications. Insert the attached Service/Construction Contractors model language including the attachment form on hazardous material (HM) storage into Division 1 of the specifications and appropriately edit both to the installation.

18.2.2. The contractor shall establish a Hazardous Material (HM) storage and distribution system when HM is to be used. All HM required to support the contract shall be reported to the Hazardous Material Pharmacy (HMP) using the Contractor HM Identification Form. The Contractor HM Identification Form will be provided to the Contractor at or prior to the Pre-Construction meeting. Additional HM needed by the contractor shall be identified to the Contracting Officer's Representative (COR) for approval by the HMP. Reference Attachment 18A.

18.2.3. The contractor planning to use HM for the work shall register with the base HMP prior to start of work in order to support the installation's compliance with Executive Order 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements.

18.2.4. The contractor shall maintain Contractor HM Identification Form for HM on the job site for inspection/verification.

18.2.5. The COR will verify that the HM identified to HMP is the only HM in use on the job site.

18.2.6. The contractor shall be responsible for the following items:

18.2.6.1. Provide a list of each material and quantity of material for all proposed Hazardous Material (HM). HM shall be construed to mean any item that is:

- A health hazard or physical hazard as defined in 29 CFR, 1910.1200(c).
- Regulated in its disposal by EPA under 40 CFR.
- Hazardous as defined by DOT regulations under 49 CFR.
- Hazardous as defined by the Dangerous Goods Regulations of the International Air Transport Association.

18.2.6.2. Provide a material safety data sheet (MSDS) for each item on the HM list.

18.2.7. The contractor shall establish a construction specific HM storage and issue location that fully complies with Federal, State and Local environmental regulations. Materials issued shall be tracked for quantities used. Unused materials shall be inventoried and removed from the ANG installation prior to close out of the contract or expiration date of the HM. Reports of materials delivered, used and removed from the installation shall be submitted to the COR monthly and prior to contract close-out.

18.2.8. The contractor shall comply with all Federal, State and Local environmental standards.

18.2.9. The contractor shall accompany the Bio-environmental Engineering Representative (BEE) and the (COR) on project close-out inspection to ensure all used/unused HM is removed from the installation. This requirement shall not be a punch list item and must be accomplished prior to the Government accepting beneficial occupancy of the facility or construction item. Reference Attachment 18B.

ATTACHMENT 18A

Contractor Hazardous Material Identification Form

Part I Date: _____

This part is to be completed by Contractor prior to the construction start date, and shall be maintained on the job site.

Contractor Company: (name)_____
Proposed work term: (date)_____to (date)_____
Contractor Point of Contact: (full name or names, phone/pager numbers, emergency 24 hour contact number, etc.)

HM to be used: MFG./Product	M.S.D.S. Attached	Quantity used	Disposal Procedures	Used/Unused material removed from ANG installation

Note: This form is good for a one-month period and is to be submitted to the Hazardous Material Pharmacy. All Hazardous Material used thereafter will be identified to the Contracting Officer's Representative for approval by the Hazardous Material Pharmacy. See Part II for Contractor close-out procedures. The Hazardous Material Pharmacy phone number is (xxx) xxx-xxxx.

Approval Signatures:

COR (Contracting Officer Representative) _____

BEER (Bio-Environmental Engineering Representative) _____

EM (Environmental Manager) _____

SO (Safety Officer) _____

ATTACHMENT 18B

Contractor Hazardous Material Identification Form
Close-Out Procedures

Part II Date: _____

Attach this form to Part I

The Contractor shall accompany the Contracting Officer Representative and Environmental Manager on the close-out inspection to ensure all used/unused HM was removed from the installation.

Close out Approval Signatures:

COR (Contracting Officer Representative) _____

BEER (Bio-Environmental Engineering Representative) _____

EM (Environmental Manager) _____

Contractor _____

SECTION 19 DEMOLITION AND REMODELING

19.1. GENERAL: Drawings shall clearly show all demolition work, demolition work limits and items/equipment to remain when remodeling.

19.2. UTILITIES: Utilities shall be disconnected and terminated in accordance with local utility supplier standards. Termination(s) shall be located as close to the primary infrastructure distribution system as possible without disturbing other infrastructure systems.

19.3. ASBESTOS WORK: Asbestos work shall include the provision of all labor, equipment materials, and transportation necessary for the proper and safe removal of asbestos containing materials. This shall include encapsulation, enclosure, handling and disposal of friable and non-friable asbestos containing materials.

19.3.1. Listed below are the major asbestos regulations for which compliance is required in ANG facility design and construction. The list is not all-inclusive. Facility design and construction must comply with all OSHA, AFOSH, and EPA requirements at federal, state, regional and local levels.

- 29 CFR 1910.1001 – OSHA Asbestos Standards for General Industry
- 29 CFR 1926.1101 – OSHA Asbestos Standards for Construction
- 29 CFR 1910.134 – OSHA Respiratory Protection Standard
- 40 CFR 61, Subpart M (NESHAP) – National Emission Standards for Hazardous Air Pollutants
- 40 CFR 763, Subpart E, Section 763-82 (AHERA) – Asbestos Hazard Emergency Response Act

19.3.2. Permits and notifications: The contractor shall be responsible for obtaining all necessary permits and/or certifications of personnel in conjunction with removal, hauling and disposition of asbestos materials. The contractor shall also be responsible for and provide timely notification of such actions as may be required by federal, state, regional, and local authorities. All fees and/or charges related to asbestos removal shall be the responsibility of the contractor.

19.3.3. The specifications shall require the contractor to submit the following for approval:

- Asbestos removal and disposal plan.
- Certification and resume of qualified independent environmental health testing laboratory.
- Copies of permits, notifications, and certifications.
- Proof of license and/or registration.
- Waste storage and disposal plan.

- Descriptions, drawings and site layouts of work site isolation enclosures, negative pressure system locations, decontamination facilities and boundaries of work areas as required for the removal process.
- Proof of disposal/manifest shall be provided to the COR within 30 days after transport to the required EPA approved landfill.

19.3.4. Specifications shall also require that any asbestos contamination as a result of damage or improper removal work shall be immediately discontinued and all areas that are likely to have become contaminated with asbestos fibers shall be thoroughly cleaned with a HEPA filter equipped vacuum or by wet cleaning methods, at the expense of the contractor.

19.4. LEAD: Lead Base Paint work shall include all labor, equipment, materials, and transportation necessary for the proper abatement and disposal of lead-based paint containing materials.

19.4.1. The following are the Federal regulations applicable to ANG projects involving lead-based paint. This list is not all inclusive and all projects involving lead-based paint must also comply with all State and local requirement:

- 29 CFR 1910.1025 - Lead (General Industry)
- 29 CFR 1910.134 - Respiratory protection
- 29 CFR 1926.62 - Lead (Construction)
- 40 CFR 260-268 - Waste Handling, Testing, and Disposal
- 40 CFR Subchapter C, "Air Programs"
- 40 CFR Subchapter D, "Water Programs"

19.4.2. The following are recommended technical sources for lead-based paint surveys and projects involving lead-based containing materials.

- EPA 315-B-98-011 – The Yellow Book: Guide to Environmental Enforcement and Compliance at Federal Facilities
- Military Handbook 1110 – Handbook for Protective Coatings and Paints for Facilities
- U. S. Army Corps of Engineers Guide Specification CEGS 02090 – Lead-Based Paint Abatement and Disposal
- Steel Structure Painting Council (SSPC) SSPC 93-02 – Industrial Lead Paint Removal Handbook Volumes I and II
- SSPC 92-04 – Industrial Lead Paint Removal: Compliance and Worker Safety
- SSPC Guide 61 (CON) – Guide for Containing Debris Generated During Paint Removal Operations

ANG Lead Management and Exposure Control Plan

- SSPC Guide 71 (DIS) – Guide for the Disposal of Lead-Contaminated Surface Preparation Debris
- National Roofing Contractors Association (NRCA) Guide to Federal Regulation of the Construction Industry

19.5. REFRIGERANT: Refrigerant must be required to be recovered from all existing A/C, refrigeration units and other refrigerant using equipment or systems that will be removed or salvaged as part of the construction. Recovered refrigerants must be required to be bottled in pressure containers suitable for shipping per DOT requirements and shall remain property of the Government. Recovered refrigerants shall be turned over to the BCE immediately upon recovery. Salvage or disposal by contractor is not permitted.